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Lawrence Livermore National Laboratory

FY97 Pollution Prevention Plan

A Strategy for the Future

April 1997

Approved by the ES&H Working Group

_____ Date _____

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DISCLAIMER

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1. Purpose of Plan

This plan is intended to document Lawrence Livermore National Laboratory's (LLNL) pollution prevention (P2) program. The plan specifies those activities and methods that are or will be used to reduce the quantity and toxicity of wastes generated at the site. Prepared to satisfy Federal and State requirements, this plan meets the Department of Energy (DOE) requirements (DOE Order 5400.1) and the State of California requirements (*Hazardous Waste Source Reduction and Management Review Act of 1989, Senate Bill, SB14*).

1.1 DOE Pollution Prevention Priorities

The DOE's *Pollution Prevention Program Plan 1996* (*1*) establishes six immediate priorities, due to be implemented by fiscal year (FY) 1998, which will help DOE Headquarters, the Operations Offices, and the sites to focus resources on the most critical aspects of DOE's P2 program. **Appendix C** of this plan, the ***DOE Pollution Prevention (P2) Activity Plan***, provides further implementation guidance for P2 activities that are considered essential to meeting DOE goals for reducing waste generation.

The six priorities are to:

1. Establish senior management commitment to P2 implementation.
2. Set quantitative, site-specific waste reduction and recycling goals.
3. Institute performance measures.
4. Implement cost-saving P2 projects.
5. Design P2 into new products, processes, and facilities.
6. Ensure that site programs comply with Federal, State, and Departmental requirements.

1.2 Mandates

1.2.1 Federal Mandates

While there are many Federal requirements for implementing P2 within the DOE (several of which will be discussed later in this section), it is important to recognize that the primary reason for P2 is that it is good business practice. Each Federal and contractor employee within the DOE is expected to make the best use of resources to achieve the most favorable outcome in any given activity. P2 can help employees do just that because it promotes efficiency, saves money, and creates a sense of shared responsibility at each site. When P2 becomes the ethic of every employee at a site, meeting the requirements discussed in the following paragraphs will not be difficult.

DOE Orders 5400.1, *General Environmental Protection Program,* and 5820.2A mandate that the management of hazardous, radioactive, and mixed wastes shall be accomplished in a manner that minimizes the generation of such wastes.

DOE Order 5400.1 requires heads of field organizations to prepare plans for their P2 awareness program activities. Such plans shall be reviewed annually and updated every 3 years. Plans were last submitted to headquarters in 1994.

The United States Congress, through the enactment of the Pollution Prevention Act of 1990, established P2 as the preferred approach to managing environmental releases. The act establishes source reduction as the national strategy of first choice to reduce the generation of pollution.

To emphasize the importance of P2, President Clinton issued Executive Order 12856, *Federal Compliance With Right-to-Know Laws and Pollution Prevention Requirements*, on August 3, 1993. The Executive Order encourages P2 leadership within the Federal government. It directs all Federal agencies to develop goals to reduce by 50% their total releases to the environment and their off-site transfers for treatment and disposal of toxic chemicals regulated under the Emergency Planning and Community Right-to-Know Act, (EPCRA), Section 313, by December 31, 1999. In addition, each Federal agency must review its specifications and standards and identify opportunities to eliminate or reduce the use of toxic chemicals. Further, each agency and each facility within that agency required to comply with EPCRA Section 313 must have a plan with goals to eliminate or reduce the unnecessary acquisition of products containing toxic chemicals.

Executive Order 12969, *Federal Acquisition and Community Right-to-Know*, signed by the President on August 8, 1995, states that "Federal agencies, to the greatest extent practicable, shall contract with companies that report in a public manner on toxic chemicals released to the environment." This statement applies to Federal contracts that are expected to equal or exceed $100,000. This Order also states that Federal agencies may amend existing contracts, to the extent permitted by law and where practicable, to require reporting.

Executive Order 12873, *Federal Acquisition, Recycling, and Waste Prevention*, October 1993, directs the appointment of Federal agency environmental executives to develop and implement acquisition programs aimed at encouraging new technologies and to build markets for environmentally preferable and recycled products. Federal agencies also must set goals for waste reduction, recycling, and the acquisition of recycled products, and report on their progress in meeting the goals.

In addition, this executive order requires that Federal agencies purchase 100% of those recycled items designated by the Environmental Protection Agency (EPA), except where the items are not available at a competitive price or available within a reasonable time, or if they do not meet appropriate performance standards. The purchase of nonrecycled versions of the EPA-designated items will require the written justification of the buyer, citing one or more of the above conditions.

Executive Order 12902, *Energy Efficiency and Water Conservation at Federal Facilities*, March 1994, directs Federal agencies to develop and implement programs, to the extent they are cost effective, aimed at:

1. Reducing overall energy use in Federal buildings 30% by 2005.
2. Increasing overall energy efficiency in industrial Federal facilities 20% by 2005.
3. Significantly increasing the use of solar and other renewable energy sources.
4. Minimizing the use of petroleum products at Federal facilities by switching to less polluting energy sources.

As required by Executive Order 12856, the Secretary of Energy, on December 28, 1994, issued *DOE's Pollution Prevention Strategy (2)*, to be implemented by all departmental elements. This document establishes P2 as DOE's primary strategy to reduce the generation of all waste streams and thereby minimize the impact of departmental operations on the environment, reduce operational costs, and improve energy efficiency and safety.

The Resource Conservation and Recovery Act (RCRA) requires hazardous waste generators to establish a program to reduce the volume or toxicity of waste to the degree determined by the generator to be "economically practicable." Hazardous waste generators must certify in their waste manifests that this requirement has been fulfilled. Generators must also identify in their biennial reports to the EPA, and in many cases to their respective state and local environmental regulatory agencies, the efforts undertaken during the year to reduce the volume and toxicity of generated wastes.

1.2.2 State Mandates

1.2.2.1 Hazardous Waste Reduction

In California, the Hazardous Waste Source Reduction and Management Review Act of 1989, or Senate Bill (SB) 14, requires documentation of existing and proposed waste minimization programs. Senate Bill 14 requires facilities that generate large amounts of hazardous waste to document their existing and proposed waste reduction measures. Under SB 14, facilities must report on the progress of waste minimization activities, changes in waste management activities, and evaluation of waste reduction alternatives every 4 years. Facilities must also develop plans for implementing future waste reduction measures.

Senate Bill 14 regulations require that every 4 years facilities prepare both a baseline waste generation report and a plan for long-term waste reduction. The evaluations address waste streams that represent 5% or more of the total hazardous waste generated annually by a facility. A facility must generate more than 26,400 pounds (12,000 kg) of hazardous waste, or 26 pounds (12 kg) of extremely hazardous waste each year to be subject to SB 14. The progress report and plans must be kept at the facility and need not be submitted, unless requested by the public or the California Department of Toxic Substances Control (DTSC).

The California DTSC also regulates management of, as well as reduction of, hazardous wastes in California. Transportation waste manifests used in California include a waste minimization certificate signed by responsible generating facility personnel. California Code of Regulations (CCR) Title 22, Section 66262.20 and its Appendix include the specific requirements for hazardous waste manifests. Similarly, DTSC regulates the preparation and submittal of Hazardous Waste Biennial Reports, which must report on the effectiveness of the hazardous waste generator's waste minimization programs.

1.2.2.2 Solid Waste Reduction

California Assembly Bill 939 (AB939) was enacted in 1989. It requires cities and counties to reduce their 1990 solid-waste-stream levels by 25% by 1995 and 50% by 2000. AB939 also details the reporting requirements for cities and counties as well as preparation of plans for achieving the goals discussed above. AB939 also includes a fine structure for cities and counties that do not make an effort to comply.

1.2.2.3 Medical Waste

In California, the Medical Waste Management Act establishes a comprehensive program for regulating the management, transport, and treatment of medical wastes that are hazardous because they contain infectious agents, biohazardous materials, body tissues or parts, or chemotherapeutic drugs. The medical waste program was originally created by enabling legislation in 1990—California Assembly Bill 109 (AB109) and California Assembly Bill 1641 (AB1641)—that enacted Chapter 6.1 in Division 10 of the Health and Safety Code (H&SC). The Act is currently located in H&SC Section Division 104, Environmental Health, Part 14, Medical Waste, Sections 117600–118360.

The Act requires the registration of large-quantity medical waste generators, transport of medical wastes by registered hazardous waste haulers (except when a small-quantity exemption applies), and operating permits for treatment facilities such as incinerators and steam sterilization units and specifies methods for storing medical waste and treating it so it may be handled as solid waste. The Act is administered by the California DTSC and is enforced by them or by local jurisdictions that elect to implement the program.

2. Scope of the Program

The P2 Program at LLNL is an organized, comprehensive, and continuing effort to systematically reduce solid, hazardous, radioactive, and mixed waste generation. The P2 Program is designed to eliminate or minimize pollutant releases to all environmental media from all aspects of the site's operations. These efforts offer increased protection of public health and the environment and will yield the following additional benefits by reducing or eliminating:

- Waste management and compliance costs.

- Resource usage.
- Inventories and releases of hazardous chemicals.
- Civil and criminal liabilities under environmental laws.

This plan is a reference tool and guidance document for DOE and LLNL managers, operations personnel, and support staff. It contains the policy, objectives, strategy, and support activities. The program reflects the goals and policies of P2 for LLNL and represents an ongoing effort to make P2 an important part of the site's operating philosophy. Information from this plan shall be disseminated through the P2 Employee Training and Awareness Program, which is detailed in Section 7.3 of this document. The key elements of this plan will be used to raise employee awareness of P2 through articles in *Newsline*, PPG's home page on the Internet, Earth Day Events, posters on bulletin boards, and presentations at various group meetings. Additionally, waste generators shall have copies of the plan made available to them at the "Hazardous Waste Generation and Certification" course (EP0006) and at the "Hazardous Waste Generation and Certification Review" course (EP0006-R). This plan will be available to LLNL employees and site contractors, as well as to the outside community via the Internet.

In accordance with EPA guidelines and DOE policy, a hierarchical approach to waste reduction (i.e. source elimination or reduction, material substitution, reuse and recycling, treatment and disposal) has been adopted and is applied to all types of waste.

The scope of this plan is confined to source elimination or reduction, material substitution, and environmentally sound recycling. P2 will be accomplished by eliminating or minimizing the generation of waste through application of source reduction techniques where appropriate. Potential waste materials that cannot be eliminated or further minimized will be evaluated to determine if it is technically practicable and economically feasible to reuse, recycle, reclaim, or decontaminate them. Moreover, selected waste streams will be treated to reduce volume, toxicity, or mobility prior to storage or disposal.

Elements of this plan include: LLNL's policies and goals, organization and infrastructure, the evaluation of waste generation, P2 implementation, and a process for continual evaluation of the program.

3. LLNL Site Information

LLNL is owned by the U.S. Government and operated by the University of California (UC) under a prime operating contract, W-7405-Eng-48, with the U.S. Department of Energy. The Laboratory was established in 1952 to carry out nuclear weapons research.

LLNL is a multidisciplinary, multiprogram, research, engineering, and testing organization. Its staff focuses its science and engineering research and management efforts on national issues associated with security, energy, the environment, biomedicine, economic

competitiveness, and science and mathematics education and responds to a special mandate with regard to nuclear weapons stockpile stewardship and treaty verification technologies.

The Laboratory's dynamic, multifaceted mission has broadened in recent years to meet new national needs, among which are the protection and restoration of the environment.

The Laboratory carries out this multifaceted mission in compliance with local, state, and Federal environmental regulatory requirements. It does so with the support of the Environmental Protection Department (EPD), which is responsible for environmental monitoring and analysis, hazardous waste management, environmental restoration, and ensuring compliance with environmental laws and regulations.

LLNL comprises two sites: the Livermore site and Site 300. The locations of the Livermore site and Site 300 are shown in **Figure 1**. The Livermore site occupies an area of 3.28 square kilometers (km^2) on the eastern edge of Livermore, California. Site 300, LLNL's experimental testing site, is located 24 km to the east in the Altamont Hills, and occupies an area of 30.3 km^2.

4. Description of the Pollution Prevention program

4.1 Senior Management Commitment

LLNL is committed to managing risk and complying with environmental, safety, and health (ES&H) regulations in the performance of its work. It expresses that commitment through a combined ES&H management. LLNL's ES&H-related policies and procedures are intended to protect the health and safety of employees and the public and to prevent damage to property or the environment. Research and development frequently involves working at the limits of technical understanding and can generate unique risks. The challenge at LLNL is to identify and manage those risks in an acceptable manner. LLNL believes that it is essential that all individuals engaged in research and engineering activities do so in a manner that proactively anticipates hazards, designs and implements effective controls, and complies with applicable ES&H regulations, so that experiments are conducted in a timely manner, at a reasonable cost, and in compliance with health, safety, and environmental protection requirements.

The Director of LLNL establishes Laboratory policy and holds the associate directors (ADs) accountable for implementing LLNL's ES&H policies as an integral part of their management responsibilities. From the ADs, responsibility for implementing these policies continues down to the individual workers. P2 is incorporated into the ES&H policies and infrastructure at LLNL.

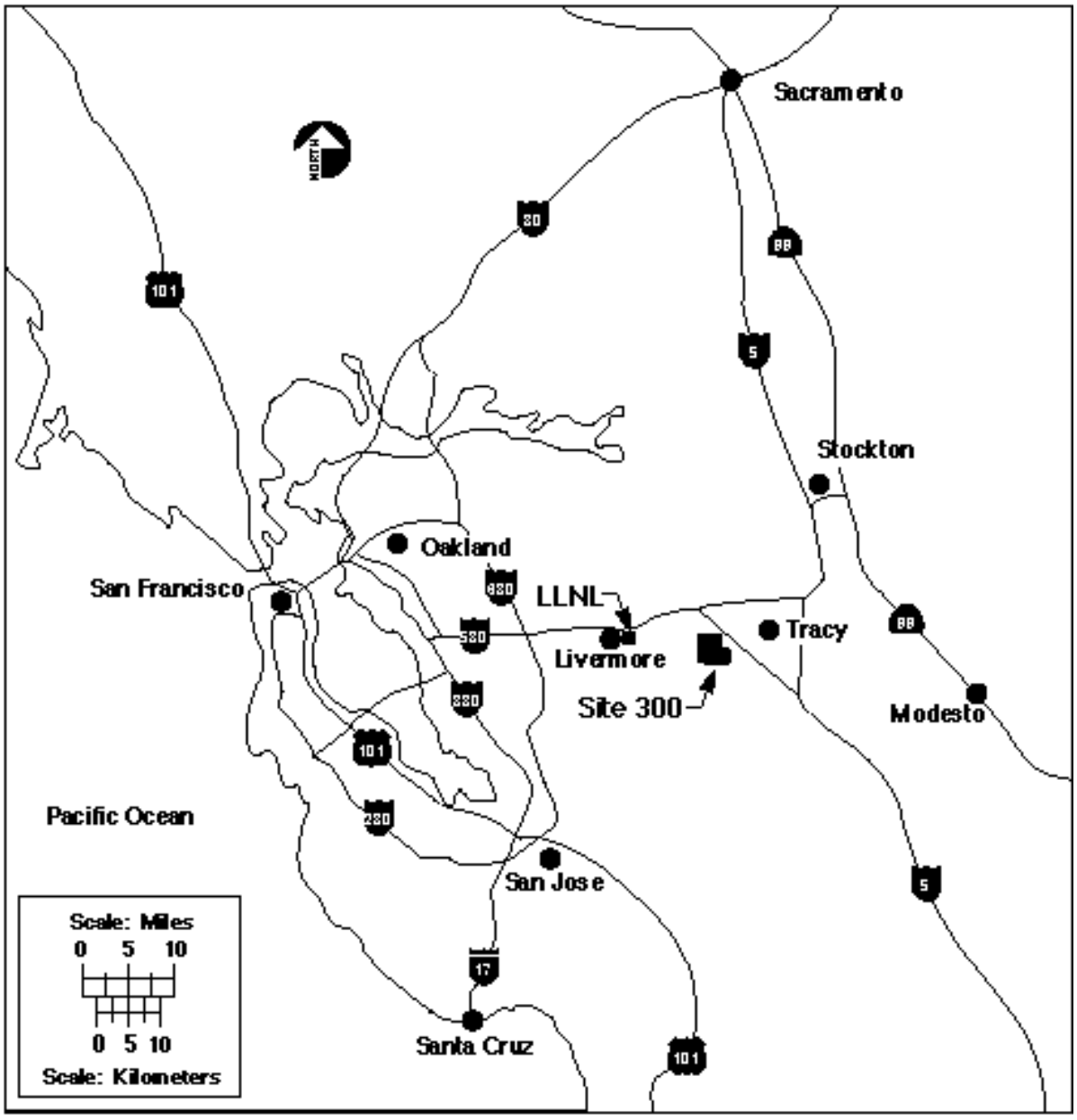

Figure 1. Locations of LLNL Livermore and Site 300.

The *Environmental Safety and Health Program Plan* (*3*) was published by the ES&H Working Group. The ES&H Program Plan also establishes the ES&H policies and procedures for LLNL operations. The document was developed at the request of the Laboratory's former Senior Management Council to bring together in one place a description of all aspects of the ES&H Program. This document is to be reviewed annually and updated as necessary at the direction of the Deputy Director for Operations (DDO) at LLNL, Robert Kuckuck, who also approves the document.

The new ES&H policy was revised in 1996 to combine three formerly separate ES&H policies into the following succinct policy statement (*4*):

> **"It is the Laboratory's ES&H policy to perform work in a manner that protects the health and safety of employees and the public, preserves the quality of the environment, and prevents property damage. The environment, safety, and health are to be priority considerations in the planning and execution of all work activities at the Laboratory. Furthermore, it is the policy of LLNL to comply with applicable ES&H laws, regulations, and requirements."**
>
> C. Bruce Tarter
> Laboratory Director

The Director's ES&H responsibilities include ensuring that the Laboratory's Environmental, Safety, and Health Program is implemented and effective and that the Laboratory complies with applicable ES&H laws and regulations and UC Contract 48 requirements (*5*). He must also ensure that open communications on ES&H matters are maintained with the Laboratory's work force, the public, and external agencies. The Director's authority extends to approval of the startup and shutdown of programs; he may appoint senior managers and delegate responsibilities and authorities to them and to other LLNL employees. In addition, the Director is the final authority regarding the development and implementation of policies and procedures and the budget. The Director is the Laboratory's Chief Executive Officer. He is also an official of the University of California. As Chief Executive Officer, the Director manages and is accountable for all Laboratory operations and activities, including ES&H.

4.2 Organization and Infrastructure

4.2.1 Policy Formulation and Implementation

Except for direction-setting policies generated by the Director's Office, policies related to ES&H are developed under the guidance of the ES&H Working Group. Policies that have significant implications for the Laboratory are forwarded to the DDO for final approval. Policy statements are published in Laboratory ES&H manuals, as Administrative Memos in the Policy and Procedure category, as integral portions of program requirements statements, and in process and procedure documents such as the Deficiency Tracking System (DefTrack) Policies and Procedures Manual. Guidance for implementing policies is published in a variety of ways, the most typical of which is in Laboratory ES&H manuals and guidelines.

4.2.2 ES&H Organization

One of the ES&H program's objectives is to establish an environmental protection program that encourages innovative approaches to waste minimization and environmental P2 and to cleaning up contaminated sites.

An unbroken chain of management responsibility and authority extends from the Director of the Laboratory through each Associate Director's organization. Four levels of responsibility and authority characterize this management chain, i.e., executives, senior managers, managers, and supervisors. Supervisory responsibilities include taking actions to minimize the generation of waste and enforcing the policies and procedures governing Laboratory waste handling practices, environment-related operating permits, and P2. Supervisors monitor operations and activities regularly and mitigate any ES&H-related problem using the principles of graded approach.

The four ES&H Teams provide services and support to programmatic and overhead organizations to help them ensure a safe and healthy workplace. These ES&H teams are fundamental to a successful implementation of the ES&H program, and they are regarded as the backbone of the organizational framework.

Each Team services specific program areas and consists of health and safety discipline members and health and safety technologists. The ES&H team organization is shown in **Figure 2**. In addition, environmental analysts from the Environmental Protection Department are matrixed into the Teams. Further definition of the ES&H roles and responsibilities at LLNL are included in **Appendix E.** Additionally, conformance with ES&H practices is included in the annual performance appraisals for all LLNL staff.

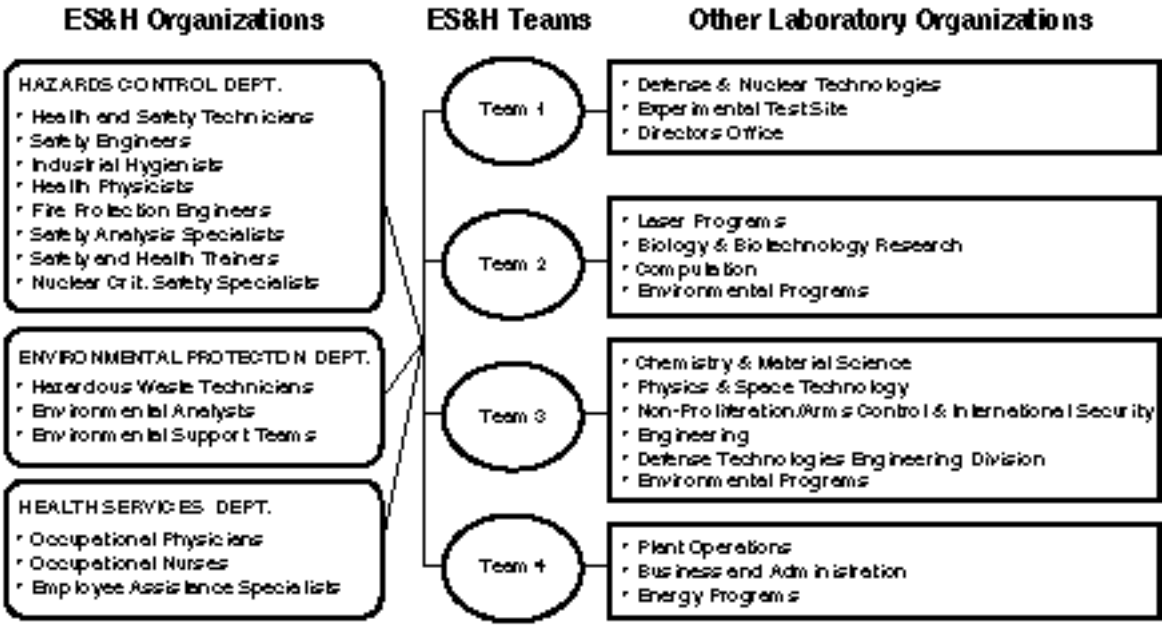

Figure 2. ES&H team organization.

4.3 P2 Implementation

4.3.1 Requirements Review and Evaluation

4.3.1.1 Awareness of External Requirements

Laboratory ES&H and P2 requirements are derived from numerous sources, but primarily from Federal, State of California, regional, and local statutes, regulations, and ordinances; DOE directives; and UC policies. These regulatory and contractual requirements are dynamic and cross many technical disciplines. The Laboratory relies primarily on the professional staff in its institutionally managed ES&H support organizations, the Office of Contract Management, and the Office of the Laboratory Counsel to maintain its awareness of new and changing regulations and DOE directives. The Laboratory interacts with regulatory agencies, UC, and DOE staff through meetings and site visits. The Laboratory also makes heavy use of modern communications systems as part of its information resources. When requested, Laboratory ES&H and P2 experts and programmatic personnel review and comment on proposed revisions to existing DOE directives, new directives, and proposed rules.

The Environmental Protection Department (EPD) is responsible for providing assistance to line management to help ensure environmental compliance, conducting environmental restoration, and assisting the LLNL organizations in carrying out their tasks in an environmentally acceptable manner. The Operations and Regulatory Affairs Division (ORAD) in EPD provides effective Laboratory-wide assistance to ensure environmental compliance. These compliance and recent regulatory review activities are discussed in more detail in **Appendix D**.

4.3.1.2 Evaluation of Requirements

Management of the appropriate ES&H support organization assigns departmental staff to review, interpret, and analyze proposed and final regulations, rules, and DOE directives. This review assesses whether the potential requirements specifically apply to the Laboratory, and if so, when they become effective and whether compliance actions will have to be implemented sitewide or will be limited to only one or a few organizations. The potential impacts on Laboratory operations are also evaluated; e.g., the need for additional training, record keeping, reporting, new instrumentation systems, and modifications of existing structures and operations.

Regulatory analysis is often performed by ad hoc teams whose members are drawn from many interested organizations including the Permits and Regulatory Affairs Group (PRAG) in ORAD, affected programs, and other EPD organizations. For Federal legislation and regulations, comments are coordinated and transmitted through DOE. For state and local regulations, LLNL provides comments directly to the regulatory agency. As a state employee (through UC Regents), LLNL is restricted from lobbying for or against proposed state legislation that may impact LLNL operations.

4.3.2 Program Development

Since the early 1990s, Laboratory management has had a formal commitment to P2. New regulations or DOE directives often require the Laboratory to implement new requirements; the Conduct of Operations Program and the Waste Minimization and Pollution Prevention Awareness Program are two typical examples.

Additionally, each directorate can also establish incentive programs. Defense Nuclear Technologies (DNT) has taken the lead role in formalizing P2 polices for Site 300. In 1992, the associate directors with activities at Site 300 signed a memorandum of understanding (MOU) committing their organizations to implement all P2 measures that are technologically and economically practicable. To help ensure that P2 was incorporated into daily activities, senior directorate managers appointed a "grass roots" waste-reduction coordinator to direct that organization's efforts, making sure that all personnel were aware of the directorate's commitment to P2 and facilitating the implementation of waste reduction and prevention measures. An updated MOU to reaffirm commitment to P2 is currently being circulated for signing by the associate directors who currently have activities at Site 300. DNT, who coordinates the MOU activities at Site 300, is also adapting the MOU concept to their facilities at the Livermore site.

New programs may also need to be developed and implemented to meet the ES&H performance measures established under Article VI, Clause 6 of Contract 48 (*5*).

An institutional implementation or compliance plan may be required that lists specific actions and milestones for implementing the new requirements. In other cases, guidance is developed as part of general guidance for Laboratory-wide distribution. The recommended actions may include such features as the development of implementation guidance and procedures, the acquisition of special equipment, the inspection and modification of buildings and utility systems, or the determination of special communications and training requirements. In addition, for some sets of requirements, performance criteria may be established in order to evaluate the effectiveness of implementation. ES&H experts develop the required programs, plans, and guidance with input from the program organizations. Institutional implementation guidance is reviewed by the ES&H Working Group and sent to the DDO for endorsement when required.

4.3.3 Directorate ES&H Self-Assessments

Requirements in the Health and Safety Manual, Supplement 2.04, (ES&H Self-Assessment Program) (*6*), mandate that each directorate conduct periodic self-assessments based on a written implementation plan. All organizational elements, facilities, operations, and support infrastructures, including safety systems, are assessed at intervals using the graded approach. Deficiencies found during self-assessment activities are recorded and tracked with the Deficiency Tracking System (DefTrack) until they are corrected. A final report for each assessment or assessment period is prepared for the cognizant associate director. This self

assessment program is a part of the continuous improvement program for pollution prevention.

4.3.4 Management Performance Self-Assessment

Under the provisions of Appendix F, Contract 48 (*5*), the Laboratory conducts an annual self-assessment to evaluate its management performance in several administrative and operational areas, including ES&H and P2. This self-assessment is made against a set of criteria called Performance Measures (PMs). The PMs are developed by representatives from LLNL, Lawrence Berkeley National Laboratory (LBNL), Los Alamos National Laboratory (LANL), UC, and the DOE. The actual self-assessment of the Laboratory is an on-going process conducted by LLNL personnel. In FY 1994–95, this self-assessment covered 22 ES&H performance measures, three of which were specifically related to waste minimization and P2.

Where necessary, corrective action plans are developed to address any significant ES&H management deficiencies that the self-assessment may disclose. The self-assessments and corrective action plans are validated by independent evaluation teams, reviewed by the DDO, and then submitted through the Office of Contract Management to UC/DOE. Corrective actions are tracked on the DefTrack System.

In addition to the Triennial Review and the PM self-assessment process, the DOE Oakland Operations Office (DOE/OAK) conducts separate management performance appraisals of the Laboratory, which include several ES&H areas.

4.4 Pollution Prevention Outreach

4.4.1 Technology Transfer and Information Exchange.

LLNL has active programs in several different directorates, which provide P2 technical guidance and information to industry in California, other states, and internationally. Specific examples are included in **Appendix F**.

5. Site Pollution Prevention Goals

5.1 P2 Goals

The Secretary of Energy has committed the Department to the following P2 goals, which are to be achieved throughout the complex by December 31, 1999, using calendar year (CY)1993 as a baseline:

1. Reduce total releases and off-site transfers for treatment and disposal of EPCRA 313 toxic chemicals from routine operations by 50%.
2. Reduce the generation of radioactive waste from routine operations by 50%.
3. Reduce the generation of low-level mixed waste from routine operations by 50%.

4. Reduce the generation of hazardous waste from routine operations by 50%.
5. Reduce the generation of sanitary waste (after recycling) from routine operations 33 %.
6. Divert 33 % of sanitary waste from all operations for recycling.
7. Increase the affirmative procurement of EPA-designated recycled products to 100%.

Progress toward achieving these goals is reported annually to the Secretary in the Site's Annual Report on Waste Generation and Waste Minimization Progress. Routine waste is defined in **Appendix A**. **Table 1** presents LLNL's future P2 waste reduction goals using the 1993 quantities as a baseline.

Table 1. P2 waste reduction goals from 1997–1999 using 1993 quantities as a baseline.

Goal	1993 (Baseline) [a]	Projected 1997 goals		Projected 1999 goals		Projected 1999 goals		By 12/31/99
	Qty[b]	Qty[b]	Reduction (%)	Qty[b]	Reduction (%)	Qty[b]	Reduction (%)	DOE reduction goals (%)
Routine operations								
Reduction of toxic chemical release inventory	2900	2320	20	2030	30	1740	40	50
Reduction of low-level radioactive waste generation	201	160	20	140	30	120	40	50
Reduction of low-level mixed waste generation	98	79	20	69	30	59	40	50
Reduction of hazardous waste generation	615	492	20	430	30	369	40	50
Reduction of sanitary waste generation	7548	2491	33	2491	33	2491	33	33
All operations								
Increase sanitary waste recycling [c]			33		33		33	33
Increased affirmative procurement of EPA-designated recycled products			TBD		TBD		TBD	100

[a] US Department of Energy, Office of Environmental Management (1996), Annual Report of Waste Generation and Pollution Prevention Progress 1994, Washington, DC, DOE/EM-0310. These previously reported numbers differ slightly from the UC PM baseline.

[b] Radioactive and mixed wastes are reported in cubic meters(m^3).

Hazardous and sanitary wastes are in metric tons (MT)

[c] % = Recycled Amount / (Sanitary waste + Recycled Amount)

5.2 Institute Performance Measures

LLNL has P2 performance measures as part of the operating contract. **Appendix B**, in this Plan, includes the P2 performance measures for FY97. These performance-based contract measures were instituted in the FY95 contract, and they have been modified each year.

The current DOE contracts with the UC for the management and operation of LLNL were truly forerunners of today's performance-based contracts. They set forth objective performance measures for key areas of administration and operations and required annual self assessments of performance to these measures, as well as performance measures for LLNL in science and technology. Based on the foundation of these contracts, the DOE/OAK has partnered with LLNL and UC to build a highly effective performance improvement system. The results of this "partnership for performance" are impressive and validate performance-based management principles.

These contracts—which, in partnership with DOE, have been completely rewritten and restructured from those of past years—represent a new and innovative approach to Laboratory management. By their design and through their implementation, the contracts seek to balance scientific and programmatic flexibility with management accountability in response to changing national priorities. They are meant to simultaneously meet the oversight needs of DOE, support the principles inherent in not-for-profit government contracting, preserve the special needs and characteristics of the laboratories and UC as a government contractor, and hold UC to high standards of management.

These efforts all promote quality improvement. Furthermore, the new UC–DOE contracts already embody many of the improvements sought by the DOE Contract Reform Team, e.g., performance-based customer involvement, increased accountability, and incentives. “Performance” is the operational word and concept represented by these changes—performance and the objective measurement of performance—to drive continuous improvement in laboratory operational and administrative management.

The senior management of each organization jointly agreed on the objective of creating an Appendix F in UC Contract 48, which reflected a balance between the measurement of performance and the determination of compliance. FY94 performance measures were geared to drive performance improvement. The quality and comprehensiveness of FY93 performance measures was greatly improved in FY94. The movement is away from simple "compliance" determinations and towards measurement of meaningful management parameters. These performance measures have assisted in institutionalizing P2 into the daily operations at LLNL.

6. Priority Waste Streams – Description and Evaluations

A requirement of this plan is to include a discussion of LLNL’s major waste streams, the progress towards achieving the DOE reduction goals, and future improvements that are possible.

6.1 LLNL's Previous P2 Accomplishments

There have been significant P2 accomplishments at LLNL since 1989; before the establishment of the CY93 baseline that has been used for the DOE reduction goals.

In 1988, the energetic materials and components testing facilities at Site 300 generated approximately 500,000 kg of waste containing such toxic materials as depleted uranium, lead, copper, and beryllium. A number of P2 measures were integrated into ongoing operations to eliminate or minimize the generation of mixed waste and to minimize the volume of low-level waste. As a result of these changes, volumes of low-level radioactive waste have been reduced by 95% since 1988, and mixed-waste generation has been limited to a very small quantity. (Given the nature of the experiments conducted at Site 300, this minimum quantity of mixed waste is unavoidable.)

The Engineering Directorate's P2 successes include converting the metal plating shop to a near-zero discharge facility by recycling its aqueous waste using a cold evaporator and replacing the vapor degreasing operations with aqueous cleaning. Coolant waste generation in the machine-shop was reduced by 42% between CY93 and CY96. This reduction is the result of substituting semi-synthetic and synthetic coolants for Trimsol and the recycling from the product recovery unit. The longer lifetime of the new coolants is dramatic. Some machines have not had the coolant changed for 2 years vs. the typical 1- to 3-month changeout required for the Trimsol.

Several other directorates have eliminated the use of toxic chemicals and hazardous materials through material substitution and process modification. LLNL has been proactive in reducing the use of toxic materials by establishing a solvent substitution program. This is discussed in the hazardous waste section 6.3.1.

EPD's Groundwater Treatment Facilities C and D at the Livermore site used to changeout the resin on an annual basis and dispose of the approximately 300 pounds of resin as hazardous waste. The resin is now regenerated in situ and the changeout is estimated to be once every 3 years, which has not adversely effected the treatment of the groundwater.

6.2 Historic Waste Generation

6.2.1 Hazardous, Radioactive, Mixed, and Sanitary Waste Generation

Routine waste generation by waste category, from CY90 through CY96, is shown in **Table 2**. The trend from CY90 on shows a dramatic reduction in all waste categories, which is the result of a proactive P2 program at LLNL.

Table 2. Routine waste generation totals, CY90–CY96 (in tons).

Waste category	CY90	CY91	CY92	CY93	CY94	CY95	CY96
Radioactive	441	267	296	307	188	143	101
Mixed	202	80	153	46	26	36	23
Hazardous	1880	1148	1200	740	510	368	351
Sanitary	2820	2295	2300	2379	2465	2246	2001
LLNL totals	5343	3790	3949	3472	3189	2793	2476

Table 3 presents the percent reductions for CY96 compared to CY95, the CY93 baseline, and CY90 for a historic perspective. The radioactive, mixed, and hazardous waste generation in CY96 have already met the 50% reduction goal for the performance measure.

Table 3. Waste reduction, CY96.

Waste category	Reduction CY96 vs. CY95 (%)	Reduction CY96 vs. CY93 (%)	Reduction CY96 vs. CY90 (%)
Radioactive	29	67	77
Mixed	37	51	89
Hazardous	2	51	81
Sanitary	11	16	29

6.2.2 Nonhazardous Solid Waste Generation

In CY96, 6136 tons of nonhazardous waste, including routine and nonroutine, i.e. sanitary waste in the above tables, was sent to a landfill. The routine portion was 2001 tons and the nonroutine portion was 4135 tons. The breakdown is shown in **Table 4**.

Table 4. CY96 Nonhazardous landfill totals (in tons).

	CY96 total
Routine	
Livermore compacted	1881
Site 300 compacted	27
Industrial (TWMS)[a]	93
Routine subtotal	2001
Nonroutine	
Construction demo	4109
Industrial (TWMS)[a]	26
Nonroutine subtotal	4135
LLNL total	6136

[a] TWMS is the acronym for the HWM's Total Waste Management System.

6.2.3 Nonhazardous Solid Waste Diversion Totals

The total waste diverted from landfills in CY96 was 20,259 tons. This large increase from last year is due to the beneficial reuse of soil on site (9000 tons), soil that is used at the landfill for daily cover (3606 tons), and asphalt that is used for road base material at the landfill (4090 tons). The waste diversion summary is shown in **Table 5**.

Table 5. Waste diversion summary table for CY96.

Description	CY95 total (tons)	CY96 total (tons)
Paper recycling		
Unbaled	254	266
Paper, baled (classified)	116	56
Paper, subtotal	369	321
Asphalt	686	4090
Batteries	38	21
Wood	406	398
Metals, ferrous	1121	1837
Metals, nonferrous	181	193
Metals, copper	78	73
Cardboard	151	159
Compost	NA	37
Diverted soil		
Off-site daily cover	794	3606
On-site reuse	NA	9000
Diverted soil subtotal	794	12,606
Food	–	1
Magazines	4	3
Non-LLNL phone books	8	7
Newspaper	6	3
Tires, scrap	30	24
Trailers[a]	–	97
Toner cartridges	<1	6
HWM recycled materials	314	384
LLNL diversion total	4186	20,259

[a] The recycled steel frames from trailer demolition were separately tracked after the third quarter of FY96.

For CY96, the total of nonhazardous waste sent to landfill and the diverted waste is 20,259 + 6,136 = 26,395 tons. The recycling rate for nonhazardous waste is calculated by dividing the diverted waste by the landfill and the diverted waste total. This results in a recycling rate of 77% for the nonhazardous waste for CY96.

This far exceeds the DOE-stated goal of achieving a 33% recycling rate of nonhazardous waste by December 31, 1999.

For LLNL's UC contract, the goal is to reduce the routine nonhazardous (compactible and industrial) waste, using CY94 as a baseline (2465 tons) by 33 % by December 31, 1999. As shown in **Table 2**, the nonhazardous waste generated in CY96 was 2001 tons, which is a 19% reduction from the baseline.

In FY97, LLNL has been chosen to receive a National DOE P2 award for its achievements in solid waste recycling of construction and demolition debris.

LLNL has been subject to California Law AB939, which requires a 50% reduction in nonhazardous solid waste between 1990 and 2000. LLNL reports annually to Alameda County for AB939. Therefore most of the significant reductions in the nonhazardous area have already occurred, and most likely LLNL will not be able to achieve the UC performance measure of nonhazardous waste reduction goal by one-third by December 31, 1999 using CY94 as the baseline because LLNL has already reduced this waste stream by 30% since 1990.

As a remote site, Site 300 has implemented programs that reduce the generation of nonhazardous waste. By reducing the amount of solid waste generated at Site 300, LLNL reduces the amount of material that must be transported to landfills. These "housekeeping" efforts include:

- Using uncontaminated soil, asphalt, and concrete generated as waste at Site 300 as fill for existing and future construction projects or as erosion control on the hillsides of Site 300. Asphalt and concrete that cannot be used at Site 300 is being evaluated for recycling into road base and sand on site or at a local recycler.
- Using scrap lumber as fuel to generate electricity at the local co-generation plant.
- Collecting recyclable paper and cardboard for recycling by an off-site vendor.
- Collecting used laser-printer toner cartridges and returning them to the manufacturer for recycling.
- Sending scrap metals to LLNL's Donation, Utilization, and Sales (DUS) for recycling.

6.3 Status of LLNL's Priority Waste Streams

Research and development is LLNL's prime task. Facilities at LLNL may generate varying amounts of nonhazardous, hazardous, radioactive, and mixed (combination of hazardous and radioactive) wastes. The types of hazardous and mixed wastes generated include organic, inorganic, corrosive, ignitable, reactive, and toxic. These and other regulated wastes are managed for disposal by the Hazardous Waste Management Division (HWM) of the EPD. Wastes that are nonhazardous and nonregulated are disposed of through the municipal trash (solids) or sanitary sewer (liquids). The hazardous, radioactive, and mixed wastes generated may be associated with operations that range in size from small, bench-scale R&D to major maintenance waste streams. As such, they are represented by widely varying quantities of a large variety of waste types. The following sections discuss the status of each priority waste stream by waste category and the current work that is ongoing to reduce these quantities.

6.3.1 Toxic Release Inventory (TRI) Status

At LLNL only one chemical, Freon 113 (also known as CFC 113), is reported as part of the Toxic Chemical Release Inventory (TRI). This reporting is required by the Emergency Planning and Community Right-to-Know Act (EPCRA). All other chemicals are in quantities below the threshold reporting levels or are in a form that does not require reporting.

Freon 113, a chlorofluorocarbon (CFC), is an ozone depleting substance whose consumption and production is slated for elimination by the year 2000. For this reason, the replacement and recycling of Freon 113 is a high priority at LLNL.

6.3.1.1 Freon Use in Major Cleaning Operations:

In 1996, LLNL prepared a sitewide Pollution Prevention Opportunity Assessment (PPOA) of Freon 113 in cleaning operations. From this report it is clear that emissions of Freon 113 from cleaning operations has been reduced approximately 32% between 1994 and 1995. In this PPOA, five cleaning operations were assessed and their respective emissions for 1994 and 1995 given (**Table 6**).

Table 6. Freon 113 usage for cleaning applications at LLNL.

Bldg	1994 Emissions (pounds)	1995 Emissions (pounds)	Usage
175	78	0	Ceramic parts cleaning
231	524	524	Cleaning of newly machined parts, old parts that are being refurbished and substrates for thin-film vapor deposition
241	707	498	Substrate cleaning
321	133	0	Wipe-cleaning of small machined parts
321	65	0	Spray cleaning of parts machined on the diamond turning machine

LLNL is reviewing the above operations to determine the technical feasibility of replacing Freon 113 with nonhazardous alternatives, the cost of implementation, and the return on investment. These operations are briefly described below.

6.3.1.2 Building 175 Ceramic Parts Cleaning

Freon 113 had been used to clean carbon and uranium oxides from ceramic parts during a once monthly cleaning of experimental equipment. The users were able to eliminate Freon 113 by substituting a commercial product called Brulin 815GD during the monthly cleaning. The product was equally effective as Freon 113, i.e. it removed approximately 30% of the ferrous ammonium sulfate contamination from the ceramic parts.

6.3.1.3 Building 231 Substrates for Thin-Film Vapor Deposition and Parts Cleaning

Freon 113 is used in this application to clean newly machined parts and old parts that are being refurbished. It is also used to clean substrates used to manufacture thin films. The users are interested in trying alternatives to the Freon 113. Brulin 815GD may be a feasible alternative.

6.3.1.4 Building 241 Substrate Cleaning

Substrates for thin-film sputtering, e.g., glass, mica, and silica, are cleaned with Freon 113 before they are placed in a vacuum chamber. Cleaning with Freon is a final rinse in a four step process. The users have decreased the amount of Freon used; however, the use of the Freon may not add to the quality of the final product. PPG reported in *Cleaning up our Act* (*7*) that several commercial products out perform Freon 113 in removing machine oil on glass slides.

6.3.1.5 Building 321 Wipe Cleaning of Small machined Parts

Freon 113 had been used to clean some parts in the numerically controlled machining shop. The users actively sought out substitutes and now use a Brulin product, which is often used in conjunction with ultrasound. In 1995, less than 5 gallons of Freon 113 had been used in this application.

6.3.1.6 Building 321 Spray Cleaning of Parts Machined on the Diamond Turning Machine

Diamond turning is a precision machining operation that requires very accurate temperature control and the maintenance of very clean surfaces. The main concern with using alternatives for the Freon 113 is the contamination of the machining coolant and the possibility of degradation of the close temperature control that is required. This requires additional experimentation and engineering analysis.

6.3.1.7 On-Site Freon 113 Recycling

In 1994, LLNL prepared a Pollution Prevention Opportunity Assessment (PPOA) for a Freon 113 recycling project associated with a copper laser dye system experiment located within Building 490. In 1995, LLNL prepared a complementary High Return On Investment (ROI) P2 Project Proposal for this same project. The project involves approximately 50,000 pounds of Freon that is generated each year as spent coolant and insulator (i.e., prevention of high voltage discharges) for the completely self-contained laser oscillators and amplifiers. Presently, the Freon is being sent off-site to a recycler and approximately 80% is being returned to LLNL for reuse. The proposed alternative is an on-site Freon 113 purification system that is capable of 95% recovery. This on-site system would eliminate the shipping of 50,000 pounds per year of Freon and eliminate an estimated waste management cost of 614 thousand dollars. (LLNL is billed by the off-site recycler for the disposal of the still bottoms, transportation, and distillation costs.) An on-site Freon 113 purification system, was ordered and is scheduled for installation and operation by the end of FY97.

6.3.2 Hazardous Waste Reduction

LLNL's hazardous waste generation has been dramatically reduced from 740 tons in the CY93 baseline to 360 tons in CY96. This represents a reduction of 51.4%, and LLNL has already achieved the DOE 50% reduction goal for December 31, 1999. This has been achieved by various Laboratory-wide, programmatic, directorate, and individual efforts.

Table 7 shows the waste streams that made up 95% of the total hazardous waste for CY96. These waste streams are listed using a specific LLNL source code, in descending order of total quantity generated. These LLNL source codes are useful in identifying the process or activity that generated the waste. A brief description of the largest waste streams and our efforts to eliminate them or reduce their waste generation follow **Table 7**.

Table 7. Routine hazardous waste totals by source code for CY96.

Source code	Description	CY96 Totals (tons)	Percent of total	Cum. Percent
A600	Sludge removal	68.3	19.4	19.4
A794	Berm water collection	43.8	12.5	31.9
A540	Oil changes–maintenance	39.3	11.2	43.1
A593	Equipment maintenance operations	25.7	7.3	50.4
A370	Spent process liquids removal (electroplating caustics)	25.5	7.2	57.6
A940	Laboratory wastes, e.g., spent solutions, lab trash (excluding biomedical waste)	18.0	5.1	62.8
A596	Emptying retention tanks	17.5	5.0	67.7
A496	Photo developing, printing, copy machine, x-ray	15.6	4.4	72.2
A090	Clean out process equipment	14.5	4.1	76.3
A491	Machining and welding operations (chips or solids)	11.1	3.2	79.5
A494	Cooling processes (e.g., Trimsol from machining operations)	10.2	2.9	82.4
A191	Cleaning with solvents	8.0	2.3	84.6
A293	Abrasives blasting operations	6.2	1.8	86.4
A499	Building maintenance	5.9	1.7	88.1
A595	Discarding empty containers	5.7	1.6	89.7
A943	Biomedical laboratory waste (e.g., spent solutions, lab trash)	5.0	1.4	91.1
A550	Filter and battery replacement	4.8	1.3	92.5
A210	Painting	3.9	1.1	93.6
A497	Explosives testing	3.2	0.9	94.5
A920	Routine cleanup wastes (e.g., floor sweepings)	2.9	0.8	95.4
	Other	16.3	4.8	100
	LLNL total	351.4	100	100

6.3.2.1 Sludge Removal (A600)

The majority of the sludge, i.e., more than 90%, comes from dead algae and dirt in the two cooling towers' catch basins at the Livermore site. Forty-nine percent of the hazardous cooling tower sludge comes from Building 291, the other 43% from Building 325. There is an ROI project in FY97 to add fiberglass covers to the cooling towers in order to decrease the growth of algae and thereby reduce the production of sludge. LLNL is also installing sand filters and an agitation system to the cooling tower catch basins at Building 291 to prevent the sludge buildup. The remaining A600 sludge is from maintenance of pits, storm drains, and other equipment. Hazardous steam pit sludge from Building 511 contributed 7% and hazardous sludge from Building 231 pit cleanout contributed 1%.

6.3.2.2 Berm Water Collection (A794)

All A794 waste consists of rainwater, which is collected in bermed areas and other retention structures. The majority of this waste is ultimately disposed of through the sanitary sewer. In 1996, the Building 865 waste stream, which contributed more than 80% of the volume of the hazardous A794 category, was reclassified as nonhazardous, based on the results of fish toxicity tests, which indicated that this waste stream was nontoxic, i.e., not California hazardous. Thus LLNL anticipates a reduction in this category in the future. Because this waste stream is generated via rainwater, there is little or no opportunity to decrease the volume of liquid generated. Opportunities to reduce the commingling of berm water with hazardous substances lies with the generators. PPG will continue to work with the generators to review all opportunities for P2.

6.3.2.3 Oil Change–Maintenance (A540)

Much of the A540 waste is generated through routine operations. Sources include such things as automotive-fleet oil changes, transformer oil, air conditioning fluid, and vacuum pump oil. Although handled and shipped as hazardous waste, the oil waste is sent to a recycler. This is approximately 74% of the total hazardous A540 waste stream.

6.3.2.4 Equipment Maintenance Operations (A593)

A one-time changeout of activated carbon filter media from Building 291 accounted for 23% of the routine hazardous waste in category A593. This media has been replaced by liquid canisters, which have an expected life of 15 years. The other 76% of this hazardous waste is generated from routine maintenance operations such as antifreeze changes on cooling systems, changeout of capacitors, and contaminated gasoline or diesel fuel. In FY97, LLNL installed an antifreeze recycling system in the Motor Pool.

6.3.2.5 Spent Process Liquids Removal (Electroplating Caustics) (A370)

The majority of the A370 hazardous waste is routinely generated by on-going operations. Electroplating operations in Building 141 and Building 322 accounted for 40% of this waste. Used hexane and water from operations in Building 845 contributed another 19% to this category. Berm water from a power station with a leaky transformer accounted for 41% of the waste in this category. This transformer has been taken out of service.

6.3.2.6 Laboratory Trash (A940)

Hazardous laboratory waste includes spent solutions and laboratory trash generated as a result of routine experimental processes. Other types of waste in this category include shot debris from explosive testing, personal protective equipment, and scintillation-cocktail waste. Examples of spent solutions that are being recycled are ethanol from dye lasers and laser optics coating processes and acetone from the aerogel manufacturing process.

6.3.2.7 Emptying Retention Tanks (A596)

All of the A596 waste was generated by routine metal finishing and printed circuit board manufacturing processes. Most of the waste was treated in a cold evaporation unit in 1996; however, 35,000 pounds had to be shipped off site because the capacity of the recycling unit was exceeded.

6.3.2.8 Photoprocessing Waste (A496)

The reduction in photoprocessing waste is tracked using the LLNL source code in HWM's TWMS database. In CY96, the photoprocessing waste generated was 31,221 vs. 39,136 lb in CY95. This represents a 20% reduction for CY96, which is partly the result of the elimination of the photoprocessing activities in Building 113 and the conversion of the photoprocessing in Building 551W (TID) to digital. The conversion of TID facilities began in October 1996, and digital-based color printing began in December 1996 as per the original schedule. TID's waste for CY97 should be reduced by about 75%. The expanded color production and the placing of the old color unit in cold standby is still scheduled to take place in August 1997. Through this digital conversion, TID has also expanded their capabilities and productivity. They are now capable of digitizing large format documents such as site maps and aerial photographs.

Two other high ROI projects are also in process. The digital acquisition system for the transmission electron microscope (TEM) in Building 241 was scheduled to be delivered by February 1997, and the estimated date for the system to be on line is August 1997. The digital image-processing system for the metallographic facility in Building 231 was received in December 1996 and is estimated to be on line in May 1997.

6.3.2.9 Site Wide Source Reduction Programs

LLNL has many diverse processes operating on site; however, several opportunities exist in cross-cutting areas such as chemical usage, cleaning operations and verification, and recycling of equipment that is no longer required by the programs. The following is a description of sitewide programs.

Chemical Tracking (ChemTrack). LLNL has developed and implemented an inventory system called ChemTrack for tracking chemical containers from time-of-receipt after purchase to time-of-disposal. Laboratory personnel participate in this program by assuring bar codes are affixed to each chemical container when received, turning in a bar code for each empty container being disposed, and supporting periodic inventories by the ChemTrack program personnel. In the future, this information will be readily available to LLNL users in order to encourage chemical exchange and reduce the unnecessary procurement of chemicals.

Chemical Exchange Warehouse (CHEW). CHEW is a program developed and implemented by LLNL to collect, store, and offer for reuse surplus chemicals. To date, CHEW has saved LLNL over $750,000 in avoided costs. Laboratory personnel participate in this program by offering surplus chemicals to CHEW before declaring them waste for disposal. Personnel are

encouraged to use surplus chemicals available through CHEW before procuring new chemicals. CHEW provides a means for the custodian of the chemical to reduce the regulatory paperwork and a quick, free alternative way for potential users to obtain the "unneeded" chemical. Once the generators are directly charged for the cost of handling, storing, treating, and disposing of unneeded chemicals as a "waste", the incentive to try alternatives, recycle, reuse, including donations to CHEW and to DUS, are predicted to increase.

Recyclable Energetic Materials Exchange (REX). Surplus energetic materials are available via the Recyclable Energetic Materials Exchange System. This is an online database system that allows LLNL researchers to easily locate and obtain surplus and recyclable explosives. These surplus materials are available at no cost to researchers, and waste generation is avoided.

Solvent Substitution. In order to reduce the environmental risk associated with usage of many problematic cleaning solvents, LLNL conducted an in-depth analysis of 75 chemical alternatives and evaluated each according to cleaning performance, health effects, and environmental impacts. As a result, 25 Laboratory shops stopped using the more problematic chemicals and switched to safer alternatives—many of them nonhazardous products that generated no toxic air emissions or liquid wastes.

6.3.2.10 Specific Waste Stream Source Reduction Efforts

Some of the more significant stream-specific activities in P2 are discussed below. These efforts have been the result of programmatic efforts to reduce waste generation in their R&D operations.

Machining and Metal Plating Operations. Machine shop coolant in the main engineering machine shops has been discussed in Section 6.1.

Recycling Solvent from the Aerogel Manufacturing Process. The Rapid Supercritical Extraction (RSCE) process for making aerogels and supercritically drying them, all in one step, involves injecting the chemicals that form the gel directly into a heated mold. The heat accelerates chemical reactions that result in the formation of a semi-solid gel and a liquid solvent that surrounds the gel. The solvent gets expelled from the gel as the heating is continued. Finally, the solvent that remains in the gel becomes a critical fluid, expands out of the gel, and condenses in the cool tubing to be collected as liquid waste. In the past, all of the solvent that was generated in this process was collected and managed as hazardous waste. The disposal costs for the spent solvent significantly impact the economic viability of the aerogel manufacturing process on an industrial scale.

A project was undertaken to demonstrate that spent solvent from the manufacture of aerogels could be reused in the manufacture of new aerogels and to establish criteria for solvent purity for various aerogels. The goal is to reduce the spent solvent waste in the aerogel manufacturing process by more than 85%. This means that the waste solvent generated at

LLNL from continued aerogel research and development would be reduced from 180 gallons per year to less than 27 gallons per year. On a much larger scale, this development of a waste minimization method will significantly enhance the prospects for commercializing aerogels by providing a solution to a key economic limitation in their production by licensing industries.

The results to date are promising. The waste methanol collected during the fast supercritical extraction process has been used to make silica aerogels of comparable quality to those made using new methanol. Adjusting the water and catalyst concentrations appears to change the gel time and gel temperature along with the appearance and density of the final aerogel. More research should be done to qualify the effluent and the final aerogel characteristics.

Energetic Waste. The synthesis and formulation of energetic materials (explosives and propellants) results in the generation of hazardous wastes, such as polymers and solvents. Some of the waste-reduction techniques implemented include:

- Screening all chemicals introduced into experiments. Such screening encourages the use of more environmentally compatible input chemicals and controls the site's chemical inventory so that stock chemicals do not become hazardous waste with time.
- Estimating more precisely the amount of explosives needed for each experiment, thereby minimizing the amount of excess explosive declared to be waste after a shot.
- Using in-process distillation and condensation of solvents driven off during the formulation of plastic explosives to reduce air emissions.
- Replacing ozone-depleting halogenated solvents, such as Freon 113, with nonhalogenated alternatives (e.g., acetone, ethyl acetate) for slurry coating plastic-bonded explosives.
- Developing a chemical process for producing mock high explosives (used in some experiments in place of actual explosives) that replaces halogenated solvents and hexane with ice water and minimizes the use of acetone.
- Recycling and reusing solvents and explosives recovered in the experiment.
- Transferring nonenergetic surplus chemicals to other laboratory researchers via the Chemical Exchange Warehouse and energetic surplus materials via the Recyclable Energetic Materials System.

Energetic materials are machined and pressed in the Site 300 Process Area. P2 approaches implemented here include:

- Developing new extrusion formulations and processing techniques that minimize the amount of explosive waste and contaminated debris generated at the end of a processing run.

- Developing new techniques for casting explosive parts to size, which eliminates the need for machining and the resulting generation of explosive waste cuttings.
- Instituting segregation procedures and systems to separate hazardous from nonhazardous wastes. This procedure alone has reduced the volume of hazardous waste by more than 95% of the volume generated in 1990.
- Collecting explosives "fines" (trimmings) during machining. The fines are segregated by specific explosive and are evaluated to determine if they are suitable for reuse. If so, they are stored as inventory and made available to other LLNL researchers via REX**.**

Site 300 Maintenance and Automotive Fleet Operations. Operation of Site 300 requires numerous support services, including a paint shop, building maintenance, equipment cleaning and maintenance, and automotive maintenance, so a systematic approach to P2 requires that the environmental efficiency of these activities be improved as well. Some of the P2 measures implemented in these Site 300 operations include:

- Replacing oil-based paints with environmentally compatible water-based substitutes to reduce the volatile emissions generated and applying paint with high-volume, low-pressure applicators to reduce the amount of paint required for a job.
- Reducing the variety of paint colors available to promote the use of leftover materials on the next job and to avoid the generation of outdated paint waste.
- Using lacquer thinner instead of methyl ethyl ketone and paint thinner as a cleaner, reclaiming spent lacquer thinner with an on-site solvent recovery unit, and reusing the reclaimed thinner in paint shop operations. The volume of organic hazardous waste has been reduced by approximately 85%, and 60% less new thinner product is needed annually.
- Testing oil generators and motorized equipment with a field oil analyzer and changing oil only when necessary instead of on a predetermined schedule to significantly reduce oil and filter wastes.
- Using water-soluble oil in a pipe threading machine to eliminate the generation of hazardous waste from oil-soaked filings.
- Consolidating all equipment and vehicle steam-cleaning operations at one location and capturing, recycling, and reusing the wastewater to conserve water and reduce (by 95%) the amount of wastewater generated.
- Implementing various other water conservation efforts to significantly reduce water required for irrigation purposes. For example, timers are set for night watering to reduce evaporation, some sprinkler systems have been converted to drip systems to reduce water usage, compacted ground is being aerated to reduce water runoff, and watering schedules have been altered to reduce total landscape watering time.

6.3.3 Low-Level Radioactive Waste Reduction

Table 8 shows the waste streams that made up 100% of the total radioactive waste for CY96. These waste streams are listed by LLNL source code in descending order of total quantity generated. A brief description of the largest waste streams (i.e., those that are 5% or more of the total) and the efforts to eliminate them to reduce the waste generation follow Table 8.

Table 8. Routine radioactive waste totals by source code for CY96.

Source Code	Description	CY96 Totals (tons)	Percent of total	Cum. Percent
A940	Laboratory wastes, e.g., spent solutions, lab trash (excluding biomedical waste)	53.8	53.2	53.3
a	Firing table debris waste from Site 300 explosive testing	24.9	24.6	77.9
a	Transuranic waste generated from Stockpile Stewardship research and development	10.0	9.9	87.8
A491	Machining/welding operations(chips or solids)	2.3	2.2	90.1
A794	Berm water collection	2.1	2.1	92.2
A494	Cooling processes (e.g., Trimsol from machining operations)	1.4	1.4	93.6
A910	Clothing and personal protective equipment	1.3	1.3	94.9
A943	Biomedical laboratory waste (e.g., spent solutions, lab trash,)	1.3	1.3	96.1
A370	Spent process liquids removal (electroplating caustics)	0.9	0.9	97.0
A010	Stripping	0.7	0.7	97.7
A710	Filtering, screening	0.6	0.6	98.3
A793	Waste analysis (e.g., samples)	0.5	0.5	98.8
A920	Routine cleanup wastes (e.g., floor sweepings)	0.4	0.4	98.9
A595	Discarding empty containers	0.4	0.4	99.6
A090	Clean out process equipment	0.2	0.2	99.8
A593	Equipment maintenance operations	0.1	0.1	99.9
A550	Filter and battery replacement	0.1	0.1	100.0
A720	Metals recovery	0.0	0.0	100.0
A400	Metal forming	0.0	0.0	100.0
A499	Building maintenance	0.0	0.0	100.0
A560	Filter and battery replacement	0.0	0.0	100.0
	LLNL total	101.0	100.0	100.0

[a] The firing table debris (24.9 tons) and TRU waste (10 tons) are not in the HWM TWMS database because they are not certified yet; however, they are considered to be generated in CY96.

6.3.3.1 Laboratory Trash (A940)

Radioactive laboratory waste includes spent solutions and laboratory trash generated as a result of routine experimental processes. The radioactive waste in this category represents more than half of the radioactive waste generated in CY96. Opportunities for reducing this waste stream are predominantly at the source. Awareness, education, training, and conducting PPOAs at the generator's sites are planned as a means to decrease production of this waste category. The option of using presaturated cleaning wipes to reduce the amount of laboratory trash generated in cleaning laboratory equipment is being evaluated.

6.3.3.2 Firing Table Debris Waste

Unique to Site 300 are the "firing tables" where explosives tests are conducted. These large gravel pads measure approximately 5000 ft^2 in area and are covered with a 2-ft-thick layer of pea gravel. The gravel absorbs the shock wave that travels through the ground when an explosive test is detonated and thereby protects the nearby underground firing bunker facility. The firing tables are outfitted with optical ports, electronic and electrical connections, gas and vacuum lines, flash radiography diagnostics, and other items. A shot tent is erected around each experiment to provide temperature and lighting control, weather protection, and protection of classified experiments from unauthorized viewing. Detonation of the experiment destroys the shot tent. Shot debris—including pieces of the experiment, the destroyed shot tent, and contaminated gravel—must be treated as low-level radioactive and, on rare occasion, mixed waste.

Implemented measures related to explosives testing include:

- Screening all materials used in experiments to identify and prevent the inadvertent, unnecessary use of hazardous materials that would generate mixed waste.
- Substituting nonhazardous steel weights for lead weights at all firing table operations to prevent the generation of mixed waste. (During testing, the weights are fragmented and co-mingle with depleted uranium from the test device.) Lead fragments plus depleted uranium must be handled as mixed waste, but steel fragments plus depleted uranium can be handled as radioactive waste alone, which is much easier to handle than mixed waste.
- Designing and installing an aluminum barrier to protect lead shielding from fragmentation and prevent the generation of mixed-waste containing lead fragments and radioactive material.
- Developing and implementing new procedures to minimize the amount of material placed on the firing table before detonations to reduce the volume of contaminated debris generated in each test.
- Developing a new shot tent design that uses 90% less material than the previous design and significantly reduces the volume of contaminated debris generated during

testing. The old tents were wood frames covered with 10-mil-thick, light-tight black plastic. The outer surface of the plastic was spray-painted with a silver coating for thermal control. After the test, all of the shot debris—primarily large, angular pieces of lumber twisted with pieces of plastic—was handled and disposed of as low-level radioactive waste. The new shot tents are made of lightweight, 3/4-inch-diameter, galvanized conduit covered with light-tight, two-ply, reinforced plastic. The plastic is purchased with white on the outside for thermal control (eliminating the need for spray painting) and black on the inside for illumination control. The shot debris now consists of nonangular metal poles, which are easier and safer to handle than the mangled lumber, and pieces of plastic. As much conduit as possible is reused in subsequent experiments, reducing the amount of new material required and the waste generated in each test. Pieces of conduit that are too damaged for reuse can be tightly packed in the waste containers (unlike the angular pieces of lumber) reducing void spaces and thus minimizing the volume of waste that must be dealt with.

- Reconditioning gravel removed after a test and reusing it in subsequent tests. After repeated tests, much of the gravel is pulverized into pieces too small to provide effective shock absorption; in addition, the gravel has become contaminated with radioactive material (e.g., fragments of depleted uranium from the test device). Instead of replacing all of the gravel from a firing pad with clean gravel (10,000 pounds) after each shot, we are "reconditioning" the used gravel. We screen out the smallest gravel particles (those less than 4 mm in diameter), also collecting most of the radioactive material, and return up to 85% of the gravel to the firing pad for reuse. This procedure greatly reduces both the amount of waste gravel that must be disposed of and the amount of new replacement gravel required to replenish the firing pad.
- Using research explosives not expended in firing-table experiments and surplus residues instead of virgin materials for training and equipment calibration operations.

6.3.3.3 Transuranic waste

In CY96 approximately 20,000 lb (10 tons) of TRU waste was generated in support of the Stockpile Stewardship program. Examples of projects that were funded directly by the program to reduce this waste stream include the following:

Stockpile Stewardship Program Activities include:

- Developing and demonstrating a plutonium die casting process that offers large reductions in radioactive waste generation, recycled plutonium scrap, and worker radiation exposure. DOE plans call for LLNL to complete development of the process in mid-FY97 and be closely involved with transferring it to LANL.
- Designing and demonstrating a bisector process module that generates minimum machining waste and reduces worker radiation exposure during pit dismantlement(s). A demonstration is planned in late FY97 at and with LANL.

- Developing and demonstrating the feasibility of using dimethyl sulfoxide (DMSO) as a substitute for a 50–50 acetone and dimethylformamide (DMF) solvent mixture to remove high explosives during weapon disassembly.
- Working to implement intelligent closed loop processing controls on the LLNL spin-forming machine used to shape uranium alloys. This will allow forming to near new shape, which will greatly reduce the volume of uranium and other wastes generated in existing processes.
- Designing a contained firing facility to replace an open-air firing table at Site 300.
- Exploring the feasibility of using kinetic energy metallization to repair parts for potential reuse.

Plutonium Handling Operations

- Finding and using a nonhazardous cutting oil to replace a hazardous hydrocarbon cutting fluid.
- Replacing lead tamper-detection tags with plastic tamper-detection tags to avoid the generation of mixed waste.
- Designing and utilizing a portable tritium processing system, which will reduce the possibility of releases and personnel exposures during tritium transfer operations.
- Developing and utilizing a waste parcel air evacuation system, which has resulted in an estimated 40 to 50% reduction in the volume of low-level waste (LLW).
- Changing the type of solidification agents used to reduce radioactive waste volume by approximately 40–50%.
- Using recyclable Kaufmann cans for storage of plutonium chips, thereby reducing the volume of TRU wastes and enhancing safety.
- Instituting a program to recycle booties instead of disposing of them as LLW.
- Changing the process used to decontaminate glove boxes by using a fixant to reduce the volume of TRU waste by approximately 80%.

6.3.3.4 Machining/Welding Operations (Chips or Solids) (A491)

A491 waste was created from machining depleted Uranium (D38). This is a routine waste stream that is not amenable to further waste minimization. This waste is generated in support of the Stockpile Stewardship Program.

6.3.3.5 Berm Water Collection (A794)

This waste water was generated by rainwater in the secondary containment of a waste retention tank at Building 212. This tank system is undergoing an upgrade, which includes the decontamination of the secondary containment and the inclusion of a leak detection

system, as part of the FY92 Tank Upgrade Project Line Item. Thus, this waste is not anticipated to be created in the future.

6.3.3.6 Cooling Processes (Like Trimsol from Machining Operations)(A494)

The activities to reduce this waste have been discussed in Section 6.1. Engineering uses a product recovery unit to recondition the spent coolant and reuse the recovered product in its machining operations. The recovery rate is about 80%.

6.3.4 Low-Level Mixed Waste

Table 9 shows the waste streams that made up 100% of the total low-level mixed waste for CY96. These waste streams are listed by LLNL source code in descending order of total quantity generated. A brief description of the largest waste streams and the efforts to eliminate them or reduce their waste generation follow the Table 9.

Table 9. Routine low-level mixed waste totals by source code for CY96.

Source Code	Description	CY96 Totals (tons)	Percent of total	Cum. Percent
A710	Filtering/screening	15.2	67.0	67.0
A940	Laboratory wastes, e.g., spent solutions, lab trash (excluding biomedical waste)	2.6	11.3	78.3
A793	Waste analysis (e.g., samples)	2.4	10.6	88.8
A370	Spent process liquids removal (electroplating caustics)	0.6	2.8	91.6
A494	Cooling processes (e.g., Trimsol from machining operations)	0.4	1.8	93.4
A491	Machining and welding operations (chips or solids)	0.3	1.2	94.6
A540	Oil changes-maintenance	0.3	1.1	95.7
A550	Filter and Battery replacement	0.2	1.0	96.7
A943	Biomedical laboratory waste (e.g., spent solutions, lab trash)	0.2	1.0	97.7
A593	Equipment maintenance operations	0.2	0.8	98.5
A750	Wastewater treatment	0.2	0.7	99.2
A640	RCRA corrective action at solid waste management unit	0.1	0.6	99.7
A990	Other	0.0	0.1	99.8
A191	Cleaning with solvents	0.0	0.1	100.0
A020	Acid cleaning	0.0	0.0	100.0
A294	Grinding and polishing operations	0.0	0.0	100.0
	LLNL total	22.7	100.0	100.0

6.3.4.1 Filtering–Screening (A710)

LLNL generates LLW and low-level mixed liquid waste streams that can be treated in the HWM tank farm to reduce volumes. The Dorr-Oliver filter cake processing of waste water at Building 514 generates a liquid and a solid waste stream. The water is separated from the other contaminants and is sewered. The remaining sludge is mixed with diatomaceous earth to solidify it. It can contain regulated metals, oil residues, and volatile organics in addition to the radioactivity, which render the matrix a mixed waste. The new treatment facility (DWTF), which is under construction, will house a cold evaporator unit to treat these waste streams. The resultant liquid from this treatment will continue to be sewerable, and the solid material will be capable of treatment or stabilization. The resultant stabilized waste should be a significantly smaller portion.

6.3.4.2 Laboratory Trash (A940)

Mixed laboratory waste includes spent solutions and laboratory trash generated as a result of routine experimental processes. The mixed waste in this category represents 26% of the total for category A940. This is similar to previous year's percentage. Opportunities for reducing this waste stream are predominantly at the source. Awareness, education, training, and conducting PPOAs at the generator's sites are planned to decrease the production of this waste volume. The option of using presaturated cleaning wipes to reduce the amount of laboratory trash generated in cleaning laboratory equipment is being evaluated.

6.3.4.3 Spent Waste Analysis (A793)

All A793 wastes are routinely generated as a result of performing sampling and analytical processes for characterization purposes. Thus, most of this waste stream offers little opportunity for cost-effective source reduction using conventional analytical chemistry methods. At LLNL we are presently reviewing the return on investment obtained by introducing microchemistry equipment into these laboratories. The estimate is that waste could be reduced by as much as 80%; however, a limiting factor may be the analytical methods required by EPA Standard, SW846.

6.3.4.4 Spent Process Liquids Removal (A370)

All A370 waste listed for CY96 is routinely generated. For CY96 this waste happens to have all been produced at Building 321 by the Engineering Directorate. Approximately a third of the waste is spent inorganic liquid, another third is used motor oil, and the remaining third is a nonhazardous detergent used in a machine shop that became contaminated with radioactivity and metals. The Engineering Directorate has taken a proactive role in the elimination and reduction of mixed waste. LLNL will continue to assess the potential for P2 for A370 wastes.

6.4 Affirmative Procurement Practices

LLNL does not have a stated policy for affirmative procurement. Recently procurement has been decentralized and Technical Release Representative (TRR) buying power has increased via the use of an LLNL credit card (PROCARD) to reduce procurement charges and improve productivity. Before one can become a TRR, specific training is required in the areas of procurement of hazardous materials and materials with recycled content. In FY96, approximately 70% of the EPA-designated products procured at LLNL were of recycled materials.

The Procurement and Materiel Organization has appointed a recycling coordinator to work closely with EPD's recycling coordinator to facilitate the purchase of items containing recycled materials as identified by EPA.

EPD's recycling coordinator works with Laboratory programs to develop pilot projects and coordinates research on available products. Education and awareness briefings are conducted regarding; the importance of using recycled products to close the loop in the recycling area and the availability of new high-quality materials with recycled content.

Activities in affirmative procurement are summarized as follows:

- LLNL is now product testing benches made from recycled plastic (started in FY96). If they pass the performance test, it is anticipated that LLNL will change it's landscaping specifications to call-out recycled plastic benches for this application. They are cheaper than their wood counterparts and should last longer.
- LLNL has removed virgin toner cartridges from Stores and only provide reconditioned ones.
- LLNL has created a Plant Engineering Affirmative Procurement Committee (replacing the General Affirmative Procurement Committee). Most of the newly designated items for FY97 are in the Plant Engineering area.
- LLNL is making limited use of retread tires at the Motor Pool (an increase over FY95). Many sizes are not available (for passenger vehicles). Tires are often replaced one-at-time and retreads cannot be mixed with virgin tires.
- One of the designated items for FY97 will be vehicular antifreeze. LLNL has installed an antifreeze recycling unit at the Motor pool, which will reduce our purchase of antifreeze.
- The FY96 report shows an increased utilization of postconsumer copy paper. The TID Print Plant has converted their stock to 99% postconsumer content paper (the other 1% is not available with postconsumer content). Stores only supplies virgin paper as a "controlled item", and justification must be provided to procure virgin paper.

- Awareness briefings at the TRR forum provide information about Affirmative Procurement Executive Order 12873 and the importance of purchasing items with postconsumer content. The LLNL Recycling Coordinator includes affirmative procurement practices in employee awareness briefings.
- The utilization of concrete containing fly ash on large projects has been reviewed but has not received final approval. PPG continues to work this issue with Plant Engineering and the regional fly ash supplier.

7. Additional Pollution Prevention Program Elements

7.1 Implementing Cost-Saving P2 Projects

Pollution Prevention Opportunity Assessments (PPOAs) are conducted before the implementation of P2 projects. The purpose of PPOAs is to characterize waste streams and identify those P2 options that can be cost effectively implemented. After a process has been selected for evaluation, the PPOA team contacts program personnel for a series of information gathering meetings, including walkthroughs, demonstrations, brainstorming sessions, and individual discussions. Included in the LLNL PPOA methodology is a return on investment (ROI) calculation and cost assessment of the options for all PPOAs. Results or recommendations are developed in cooperation with program personnel and are thus technically evaluated for cost, ROI, technical feasibility, and feasibility of implementation.

The DOE–EM provides competitively allocated funding to P2 projects through the High ROI P2 Program. This program encourages proposals for the implementation of P2 projects that provide a high ROI through reducing waste and associated waste management costs. LLNL participates in this program to obtain funding for cost-effective P2 implementation projects. Over $2 million of High ROI projects have been proposed to DOE–EM and to date LLNL has received over $1.7 million in funding for these projects. LLNL additionally uses ROI calculations and estimates of project cost-effectiveness to prioritize P2 projects for resource allocation and implementation at the Laboratory.

7.2 Design P2 into New Projects, Processes, and Facilities

7.2.1 Review of New Processes or Experiments

Many organizations at LLNL use a "front end" review process that applies to new programs, projects, or experiments that could have a significant impact on the environment. In this review process, the initial hazardous materials projected to be used are identified and concentrations of both the starting materials and the wastes produced are estimated. The possibility for chemical substitution, process changes, and recycling is then addressed. If an opportunity for P2 is identified, PPG will assist the generator in the evaluation of options. Researchers and project managers are encouraged to implement alternatives that are less hazardous or nonhazardous.

Defense Nuclear Technology's (DNT) experience is that implementing highly effective P2 techniques often requires only minor changes with little or no capital costs and can often be funded directly by Programs. Furthermore, they have demonstrated that with awareness, P2 concepts can be easily integrated into operations in the same way as safety concepts. All DNT P2 efforts, both at Site 300 and at the Livermore site, rely heavily on individual employee participation. DNT believes that employees are the best resource for identifying ways to eliminate or minimize waste since they are most familiar with the actual materials, processes, procedures, and product of their operations.

In general, P2 activities are covered by the pertinent directorate's P2 Plan. New activities are reviewed to identify possible P2 techniques. Projects and experiments performed by LLNL are evaluated for P2 opportunities. All personnel are encouraged to implement reasonable P2 opportunities that have been identified.

In the Chemistry and Materials Science Directorate, researchers and project leads prepare a Project Work Plan (PWP) for new activities or significant changes to existing activities. The PWP requires that P2 opportunities be considered and is the basis for conducting PPOAs on new activities. Several other directorates conduct a similar review process for new projects or significant changes to existing ones. On request, the PPG will prepare a PPOA for these projects. The PPOAs address the potential for use of less or nonhazardous materials or methods. They can also document the lack of viable alternatives.

7.2.2 Design for Environment

Design for Environment (DfE) is a nascent field, with a number of methodologies and definitions floating around. In general, any means of accomplishing the goal of minimizing environmental life cycle impacts can be thought of as an element of DfE. The DfE concept involves developing an understanding of and consideration for minimizing environmental impact over the lifetime of a project, and mitigating potential environmental impacts by overlaying this understanding directly onto the design of the project. Federal facilities are now required, under Executive Order 12856, to apply life-cycle analysis (LCA) and total cost accounting (TCA) principles to the greatest extent practicable when estimating P2 opportunities. Both of these can be considered elements of a new Federally funded facility. In addition, Executive Order 12873 required Federal facilities to, in part, implement P2 by giving preference to the purchase of environmentally preferable products. In light of these developments, traditional methods and tools employed for management and accounting may not be sufficient or effective enough in and of themselves to meet the requirements of EO 12856.

PPG, in conjunction with the National Ignition Facility (NIF) project management, has undertaken a DfE evaluation of the opportunities within the NIF Project and has made recommendations for focused studies that might also have the most immediate impact in areas of greatest concern to project management (i.e. P2, environmental compliance, cost, etc.).

Approximately 20 potential study areas have been identified, and several are being actively pursued (development of cleaning concepts and identification of P2 opportunities during special equipment design).

Additionally, P2 measures that are technically and economically practicable are being considered in the design of the Site 300 Contained Firing Facility (CFF). Lists from architectural information exchanges and from P2-design documents are provided to the CFF design team for evaluation. The CFF project has an individual designated as the P2 coordinator for the project.

7.3 Implement P2 Employee Training and Awareness Programs

The four Environmental Support Teams (ESTs), previously discussed in Section 4.2.2, assist LLNL programs with environmental issues through the appropriate ES&H team. Each EST consists of individuals specializing in specific environmental disciplines such as the National Environmental Policy Act (NEPA), permits, waste minimization, or waste management. Support is available either directly from the EST discipline or through the ES&H team environmental analysts. Environmental analysts serve as liaisons between the ESTs and ES&H teams.

P2 awareness information, which covers all disciplines is disseminated in the following forums:

- New Employee–Contractor Orientation
- EST meetings
- LLNL's Waste Minimization Steering Committee
- Presentations to the Environmental subcommittee
- Personnel are sent to DOE's P2 conferences and workshops
- Facility walkthroughs
- Earth Day
- Energy Fair
- Posters and videos
- Individual or group training sessions with generators
- Presentations to waste management personnel
- EP0006, a required waste generator training class
- Documents such as: the Waste Acceptance Criteria, PPG brochure, PPG WEB page

Newsline (LLNL's weekly newspaper) articles and administrative memos are other ways that P2 awareness is promoted. PPG has developed a WEB site to electronically distribute P2 information and also prepares brochures that briefly describe the P2 program at LLNL.

PPG also conducts monthly reviews of the HWM's Total Waste Management System (TWMS) database. This database tracks waste generation, and it affords PPG the opportunity to identify potential problem waste streams for each directorate and address issues in real time.

7.4 Develop P2 Incentives Programs

There is not a sitewide P2 incentives program at LLNL. The indirect results of several programs that are in place at LLNL have a positive influence on P2 activities at LLNL. For example, DNT sponsors an award program for P2 programs that are defense program related. As an incentive, individuals who make significant contributions to P2 are recognized by their associate directors and line managers in a DNT-sponsored award ceremony. The honorees are presented with a special lapel pin, a letter of commendation from their associate director, and a certificate acknowledging their commitment to P2. In addition to being recognized by peers, honorees are provided with opportunities to present noteworthy accomplishments at international and national symposia.

LLNL is preparing to send waste generators "mock bills" for "full cost" recovery of the waste that is generated. It is anticipated that, in the future, full cost recovery may become a requirement. Because there is a 2-year budget cycle, waste generators need to forecast and budget for future waste costs.

8. Evaluation of Activities

8.1 Prioritization of Waste Streams

LLNL is required by the UC Contract performance measures to annually review its waste generation for P2 opportunities and to propose implementation projects. These measures are discussed in **Appendix B**. The PPG has previously evaluated waste streams at LLNL in terms of the total quantities of waste generated. However, the waste streams of greatest concern are not necessarily those identified as the largest by volume. Each process that generates waste must be considered, as well as the individual characteristics of the components within each waste stream.

To better rank the waste streams and to improve the prioritization of waste minimization efforts, the PPG has developed a new, alternative weighted ranking system. The methodology assigns to each waste stream three weighting factors in addition to a factor based on quantity of waste generated annually. The three additional weighting factors use the following criteria: cost, waste type (which includes compliance and liability considerations), and operational aspects (such as routine vs. nonroutine). This is discussed in *Reassessment of LLNL Waste Generation for Calendar Year 1995 (8*).

In general, the 20 waste stream components having the highest priority (ranked by summing the four weighting factors) are entirely different than the top 20 source codes ranked by quantity only. For example, TRU/TRU mixed and low-level wastes, which are problematic at LLNL, are now ranked as having the highest priority, though their relative quantities are somewhat low.

8.2 Perform P2 Cost/Benefit Analyses

LLNL is evaluating the application of cost assessment methodologies to the evaluation of P2 opportunities. Adaptation of total cost assessment (TCA) methodologies to DOE P2 projects has begun with development of simplified total cost assessment methods for determining waste management total costs.

Adaptation of activity-based cost (ABC) assessments to LLNL waste generation and waste handling has also begun. At LLNL, we are beginning to develop some activity-based process models of waste streams, leading to costs associated with the streams. The goal of this work would be to provide input on true costs to management, to show where in the life cycle costs are apportioned and to demonstrate to waste generators that they incur a significant cost in creating and managing waste and should thus place greater emphasis on reducing their waste streams.

8.3 P2 Investments

Many projects incorporate P2 activities. All proposed projects are reviewed by an Environmental Safety and Health (ES&H) Team for compliance with applicable regulations, best management practices, LLNL policy, and to give recommendations for P2. The procedure for evaluating proposed projects is outlined in the LLNL document The Environment, Safety, and Health Program at LLNL (published by the ES&H Working Group, LLNL, June 1996)(*3*).

8.3.1 Current Return on Investment Projects

Some of the PPOAs led to the preparation of High Return-on-Investment (ROI) P2 Project Proposals in 1996. The major ROIs that were completed or were ongoing in 1996 follow:

- Microwave Digestion Equipment—Installation of equipment for the analytical laboratory, to replace acid-digestion methods.
- TID Digital Photography Equipment —Purchase digital imaging components.
- Photomicrographs, Building 321—Purchase electronic imaging system.
- Ultra-High Vacuum—Remove low-particulate contamination for ultra-high vacuum and clean room applications with nonhazardous solvents.
- Digital Acquisition System—Purchase electronic imaging system for the transmission electron microscope (TEM).

- Nondestructive Analysis Waste Sampling—Purchase equipment for field analyses and develop methods to reduce number of samples collected.
- High Explosives Water Recycling System—Install waste water recycling systems for Site 300.
- Uranium Cutting Tools—Purchase equipment and develop methods to produce high-quality machine cutting tools capable of dry-machining materials.

8.4 Challenges for P2

As with most sites, challenges for P2 include the same list of items that are given in DOE's Pollution Prevention Program Plan 1996 (*1*). Items that particularly affect LLNL are:

- P2 funding.
- Financial incentives and disincentives.
- Dissemination of up-to-date information.
- Accurate understanding of on-site waste generation.
- Quantifying results for alternatives and substituted products and equipment.

Costs continue to be a significant factor as LLNL treats, stores, and disposes of waste from laboratory research and development, legacy wastes, and environmental remediation activities. The Laboratory will generate additional wastes as facilities are decontaminated and decommissioned and as new research and development projects are brought on-line. Through early investments in sampling and analysis, segregation planning, source reduction, and environmentally safe recycling, the Laboratory could significantly reduce future waste management costs. This would simultaneously minimize health risks to its workers and the public. As LLNL reduces waste generation associated with an activity, it avoids spending a significant amount in future waste management costs.

9. Resources and Schedules

Annually, overhead budget requests are prepared by cognizant associate directors for institutional ES&H activities such as the functions and operations of the Hazards Control (HC), Environmental Protection (EP), and Health Services (HS) Departments. Proposed budgets include requests to fund the core activities (maintenance of existing capabilities) in the departments and compliance-related items; e.g., implementation of Contract 48 Performance Measures, new DOE directives and environmental regulations. Items in the budget requests from the HC, EP, and HS Departments are prioritized with the aid of a risk-benefit–cost-analysis tool. (The prioritization tool is based on multi-attribute utility theory and is still being developed.) Budget requests for supporting institutional ES&H activities are submitted to the Laboratory's Budget Office and become part of the total overhead budget request. In addition to ES&H-related costs, the overhead budget category includes the costs

for all institutionally managed (indirect) functions, e.g., safeguards and security, business operations, human resources, etc. Institutional Review Teams review the budget requests, and options are formulated for senior management review and the director's decision. Costs for indirectly funded ES&H activities are paid through overhead (a "tax") on the direct programmatic funding.

In addition to the institutional costs for ES&H activities, ES&H costs are also incurred by Laboratory programs (direct costs). The budgets prepared by the associate directors for their program activities include some core ES&H and compliance-related items. However, most ES&H-related costs, e.g., the preparation of safety procedures, training of personnel, self-assessment activities, etc., are considered part of the normal programmatic activities and are not budgeted or tracked separately from the program costs.

9.1 Long-Range Planning

At the request of DOE, the Laboratory prepares and annually updates the ES&H Management Plan. This 5-year planning document covers projected activities (tasks), milestones and costs associated with reducing risk, achieving compliance with ES&H requirements, and fulfilling compliance activities. The document includes budget forecasts for core activities, planned compliance, and unfunded compliance—improvement items in the indirect and direct (i.e., program-funded) budget categories.

Table 10. Funding levels for P2 program.

Fiscal Year	Requested ($K)	Actual ($K)
1996	1050	933
1997	1050	933
1998	1050	NA

9.2 Programmatic Funding

As P2 is designed into new projects using best management practices it is very difficult to track the amount of funding that is required. Programmatic funding in general, is not set aside for P2 planning, design, nor implementation; thus, it is not separately accounted for in budget activities.

References

1. U.S. Department of Energy, Office of the Secretary (1996) *Pollution Prevention Program Plan, 1996*, Washington, DC, DOE/S-0118.

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3 *The Environment, Safety, and Health Program at Lawrence Livermore National Laboratory*, Lawrence Livermore National Laboratory, Livermore, CA, January (UCRL-AR-119618).

4. Lawrence Livermore National Laboratory, Administrative Memo, Policy and Procedure, *Environmental, Safety, and Health Policy,* Vol. 26, No. 10, November 8, 1996.

5. University of California, Contract Between The United States of America and The Regents of the University of California For Management of the Lawrence Livermore National Laboratory, Contract No. W-7405-Eng-48, Oct. 1, 1992, http//www.llnl.gov/comix/comix/.

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7. *Cleaning up our Act*, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-ID-115831.

8. J. Celeste, *Reassessment of LLNL Waste Generation for Calendar Year 1995*, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-AR-125047.

Appendix A: Glossary of Terms and Acronyms

Activity Data Sheet (ADS)—Budget document that contains the essential scope, schedule, cost, and management information prepared by Operations Offices to provide input to the budgeting process. They are fundamental building blocks of the ES&H Management Plan(*3*).

Affirmative Procurement Program—A program that ensures that items composed of recovered materials will be purchased to the maximum extent practicable, consistent with Federal law and procurement regulations (RCRA, Section 6002). Guidance on this program has been issued and is updated as EPA issues additional guidelines.

Annual Report on Waste Generation and Wage Minimization Progress—An annual report, which chronicles ongoing Departmental waste generation activities and discusses waste minimization activities underway at DOE sites.

Baseline Environmental Management Report (BEMR)—Congressionally mandated report prepared by the Secretary of Energy to estimate the cost and schedule of cleaning up the nation's nuclear weapons complex.

Byproduct —Under the Resource Conservation and Recovery Act, a byproduct is a material that is not one of the primary products of a production process and is not solely or separately produced by the production process. Examples are process residues such as slags or distillation column bottoms. The term does not include a co-product that is produced for the general public's use that is ordinarily used in the form in which it is produced by the process.

IIE(2) Byproduct Material—As defined by Section II e (2) of the Atomic Energy Act of 1954, as amended, and Department of Energy Order 5820.2A, II e(2) byproduct material is “the tailings or waste produced by extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.” Ore bodies depleted by uranium solution extraction operations and which remain underground do not constitute byproduct material.

Cleanup / Stabilization Waste—Cleanup / stabilization encompasses a complex range of activities including environmental restoration of contaminated media (soil, groundwater, surface water, sediments, etc.); stabilization of nuclear and nonnuclear (chemical) materials; and deactivation and decommissioning (including decontamination) of facilities.

Cleanup / stabilization waste consists of one-time operations waste produced from environmental restoration program activities, including primary and secondary wastes associated with retrieval and remediation operations, "legacy wastes," and wastes from decontamination and decommissioning / transition operations. It also includes all TSCA regulated wastes, such as polychlorinated biphenylcontaminated fluids and / or equipment.

Note that cleanup / stabilization activities that generate wastes do not necessarily occur at a single point in time, but may have a duration of several years, during which time wastes are produced. By definition, these activities are not considered to be routine (periodic and / or on-going), because the waste is a direct result of past operations and activities, rather than a current process. Newly generated wastes that are produced during these "one-time operations" are considered to be a secondary waste stream, and are separately accounted for whenever possible. This secondary (newly generated) waste usually results from common activities such as handling, sampling, treatment, repackaging, shipping, etc.

Cognizant Secretarial Office (CSO)—An office within the Department of Energy. headed by an Assistant Secretary or organizational Director, that reports to the Secretary and has management responsibility over designated multiprogram operations Offices and National Laboratories.

Decommissioning—Actions taken to reduce the potential health and safety impacts of contaminated DOE facilities, including activities to remove a facility from operation, followed by decontamination, entombment, dismantlement, or conversion to another use.

Direct P2 Funding—Funding provided exclusively for P2 activities.

Disposal—Emplacement of waste in a manner designed to isolate it from the biosphere, with no intention of retrieval for the foreseeable future, and that requires deliberate action to regain access to the waste.

DOE Orders—Internal requirements that establish DOE policy and procedures for compliance with applicable laws and regulations.

Environmental Restoration—Cleanup and restoration of sites contaminated with radioactive and / or hazardous substances during past production, accidental releases, or disposal activities.

Facility—Any building, structure, system, process, equipment, or activity that fulfills a specific purpose on a site.

Generator-Specific P2 Programs—Programs for identifying, evaluating, and implementing process and equipment modifications to achieve actual reductions in waste generation and pollutant release.

Hazardous Waste—IIe statutory definition found in section 1004(5) of RCRA (42 USCA 6903) is: a solid waste, or combination of wastes, that because of its quantity, concentration, or physical, chemical, or infectious characteristics, may (a) cause or significantly contribute to an increase in mortality or in serious irreversible, or incapacitating reversible illnesses, or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Criteria for

identification and listing of hazardous wastes are found in Title 40 of the Code of Federal Regulations, Part 261.

Infrastructure—The basic facilities, equipment, relationships, and frameworks needed for the functioning of a system or organization.

Legacy Waste—The backlog of stored waste remaining from the development and production of U.S. nuclear weapons, about which a permanent disposal determination remains to be made; i.e. waste that is currently in storage, retrievable storage on bermed pads, or buried in trenches.

Life Cycle—The stages of a product's, process's, or package's life, beginning with raw material acquisition, continuing through processing, materials manufacture, product fabrication, and use, and concluding with any variety of waste management options, including recycling.

Line Organization—An organizational chain of command, which extends from an Assistant Secretary or organizational Director down through the staff levels of a Departmental organization (see also Cognizant Secretarial Office).

Low-Level Radioactive Waste—Radioactive waste not classified as high-level waste, transuranic waste, spent nuclear fuel, or by-product material (specified as uranium or thorium tailings and waste in accordance with DOE Order 5820.2A).

Mixed Waste—Waste that contains both radioactive and hazardous components as defined by the Atomic Energy Act, TSCA, and RCRA. Mixed waste is further defined here as transuranic mixed, low-level mixed, and TSCA-regulated mixed.

Pollution Control—Measures that are applied after waste and pollutants are generated, such as: off-site recycling, waste treatment, concentrating hazardous or toxic constituents to reduce volume, diluting constituents to reduce hazard or toxicity, or transferring hazardous or toxic constituents from one environmental medium to another,

Pollution Prevention—The use of materials, processes, and practices that reduce or eliminate the generation and release of pollutants, contaminants, hazardous substances, and waste into land, water, and air. For DOE, this includes recycling activities.

Pollution Prevention Act of 1990—Establishes source reduction as the strategy of first choice for waste management.

Pollution Prevention Executive Board—Established in 1992 to provide overall departmental leadership and direction for P2. Members include all CSOS. In 1996 the Under Secretary assumed the chairmanship.

Pollution Prevention Opportunity Assessment (PPOA) —Evaluation and appraisal of a process, activity, or operation as a way to identify potential waste minimization opportunities. Formerly called Process Waste Assessment.

Pollution Prevention Performance Measures —Systems or techniques to measure P2 progress by quantifying the amount of pollution not generated as a result of implementation of P2 activities.

Resource Conservation and Recovery Act (RCRA) Regulated Waste—Solid waste, not specifically excluded from regulation under 40 CFR 261.4, or delisted by petition, that is either listed hazardous waste (40 CFR 261.30-261.33) or exhibits the characteristics of a hazardous waste.

Reclamation—The process of recovering a usable product from, or regenerating, materials that have been used at least once (e.g., recovery of lead from spent batteries, or regeneration of spent solvents).

Recycled—A material is recycled if it is reused or reclaimed (40 CFR 261.1 [7]).

Return-On-Investment (ROI) P2 Projects—Specific P2 projects that rapidly pay for themselves (preferably, in 3 years or fewer) through reducing future pollutant generation.

Routine Operations Waste—Normal operations waste produced from any type of production, analytical, and/or research and development laboratory operations; treatment, storage, or disposal operations; "work-for-others;" or any periodic and recurring work that is considered ongoing. The term "normal operations" refers to the type of ongoing process *(e.g.,* production) not the specific activity that produced the waste. Periodic laboratory or facility clean-outs and spill cleanups which occur as a result of these processes are also considered normal operations.

Sanitary Waste—Wastes, such as garbage, that are generated by normal housekeeping activities and are not hazardous or radioactive.

Site—Land, installations, and facilities for which DOE has or shares responsibility for environmental restoration or waste management activities.

Sitewide P2 Programs—Broad P2 activities that must be performed on a collective, sitewide basis, Includes implementing the policy of infrastructure activities and establishing sitewide source reduction and recycling programs and progress evaluation.

Small Site—One whose waste generation rates fall below the thresholds established by the Resource Conservation and Recovery Act.

Source Reduction—Any practice that reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment or disposal; and any practice that reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants.

Stabilization—Actions taken to further confine or reduce the hazards associated with contaminated sites, areas, buildings, or equipment.

State Regulated Waste—Any other hazardous waste not specifically regulated under RCRA, which may be regulated by state or local authorities, such as used oil.

Treatment —Any method, technique, or process (including neutralization) designed to change the physical, chemical, or biological character or composition of any hazardous, radioactive, or sanitary waste so as to neutralize such waste, to recover energy or material resources from the waste, or to render such waste nonhazardous; safer to transport, store, or dispose; or amenable for recovery or storage; or reduced in volume.

Toxic Substances Control Act (TSCA) Regulated Waste—Individual chemical wastes (both liquid and solid), such as polychlorinated biphenyls that are regulated by the Toxic Substances Control Act.

Waste Generator—Individual, group, or organization at a facility that produces waste.

Waste Management—The systematic administration of the collection, storage, transportation, transfer, processing, treatment, and disposal of waste.

Waste Minimization—An action that economically avoids or reduces the generation of waste by source reduction, reducing the toxicity of hazardous waste, improving energy usage, or recycling. This action will be consistent with the general goal of minimizing present and future threats to human health, safety, and the environment.

Waste Reduction Steering Committee—Established in July 1988 to develop the DOE Headquarters P2 program and provide guidance to sites. The Committee is composed of representatives from all DOE Headquarters offices.

ACRONYMS

AD	Associate Director
ADSs	Activity Data Sheets
BEMR	Baseline Environmental Management Report
CHEW	Chemical Exchange Warehouse
CSO	Cognizant Secretarial Office
CY	calendar year
DfE	Design for the Environment
DNT	Defense Nuclear Technologies
DOE	Department of Energy
DP	Office of Defense Programs
DUS	Donation, Utilization and Sales
EE	Office of Energy Efficiency and Renewable Energy
EH	Office of Environment, Safety and Health
EM	Office of Environmental Management
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPD	Environmental Protection Department
ER	Office of Energy Research
ES&H	environment, safety and health
FE	Office of Fossil Energy
FY	fiscal year
H&SC	California Health and Safety Code
HWM	Hazardous Waste Management Division
LLMW	low-level mixed waste
LLW	low-level waste
m^3	cubic meters
MT	metric tons
ORAD	Operations and Regulatory Affairs Division

PPOAs	Pollution Prevention Opportunity Assessments
RCRA	Resource Conservation and Recovery Act
RDDT&E	Research, Development, Demonstration, Test, and Evaluation
REX	Recyclable Energetic Materials Exchange
ROI	Return on investment
TOXNET	The National Library of Medicine's on-line database that contains TRI data.
TRI	Toxic Chemical Release Inventory
TSCA	Toxic Substances Control Act
TWMS	HWM's Total Waste Management System
WRSC	Waste Reduction Steering Committee

Appendix B: UC/DOE/LLNL
Contract 48 –Appendix F Performance Measures

Pollution Prevention Performance Measures

	CRITERIA:		PERFORMANCE MEASURES:
1.2	**Waste Minimization** The Laboratory has a program in place to reduce both the amount of waste generated for disposal and pollutant emissions. **(Weight = 14%)**	1.2.a	**Waste Reduction and Recycling** The Laboratory continues to progress towards meeting the DOE's pollution prevention goals for the year 2000. **(Weight = 7%)**

Assumptions:

- DOE's pollution prevention goals by waste type, that are measured by this performance measure, are defined as follows:
  - Reduce by 50% the generation of radioactive waste (defined as TRU and LLW) from routine operations
  - Reduce by 50% the generation of low-level mixed waste from routine operations
  - Reduce by 50% the generation of hazardous waste from routine operations
  - Reduce by 33% the generation of nonhazardous waste from routine operations

- For FY97 the performance period is January 1, 1996 through December 31, 1996.
- CY93 waste generation quantities will be used as a baseline for measuring waste reductions. (CY94, corrected to reflect previous years improvements, will be used for nonhazardous waste at LLNL)
- Recycling, reuse and exchange are considered to be a method of waste minimization and will be tracked.
- Any significant new project, activity or increase in workload will be evaluated for pollution prevention / waste minimization opportunities. After pollution prevention / waste minimization opportunities are implemented for the project or activity, the resulting new waste stream will not be included in the waste reduction calculation. Pollution prevention opportunities are tracked in 1.2.b.
- Cleanup and stabilization waste (including environmental restoration waste, stabilization of nuclear and nonnuclear materials, and deactivation and

decommissioning of facilities), legacy, construction debris and USEC waste will not be included in the calculations for meeting the waste reduction goals but will be included in the discussion on meeting the recycling goal.

- Waste generation will be reported and measured in the same way that it has been reported for this performance measure in previous years.
- For scoring purposes, consideration will be given for proactive programs carried out in the five years prior to the 1993 baseline year when that program resulted in significant (i.e., greater than 50%) reductions of major waste stream types. This consideration is intended to avoid penalizing early, successful waste minimization programs that are continuing.

Gradient:

Progress toward reduction goals are evaluated by using the following set of criteria or progress on an agreed- to "waste type" reduction plan:

Meets Expectations:

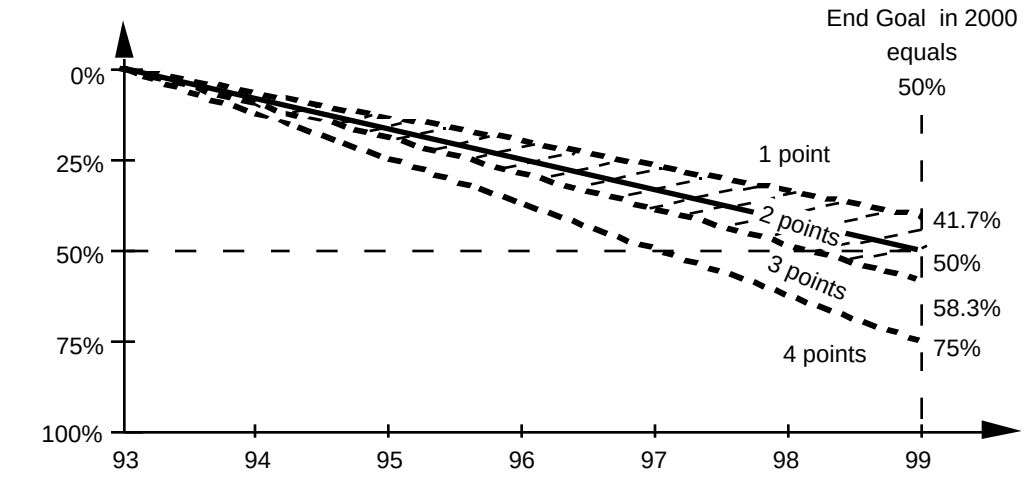
- A reduction in generation of each waste type is calculated and scored (1 to 4 points) then summed. The sum for the four waste types is 7, 8, or 9 points.

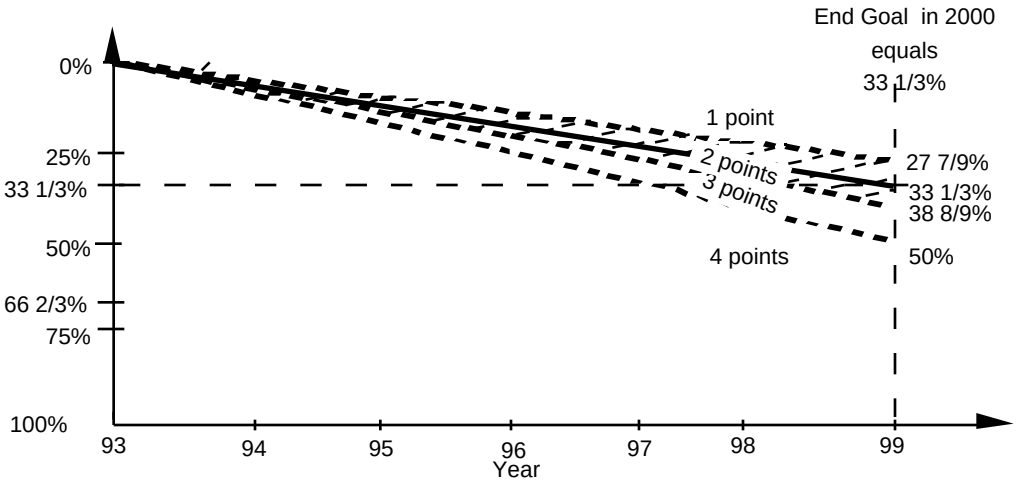
Exceeds Expectations:

- A proactive management strategy is in place for recycling and substituting materials and modifying processes.
- A reduction in generation of each waste type is calculated and scored (1 to 4 points) then summed. The sum for the four waste types is greater than 9 points but less than 12.

Far Exceeds Expectations:

- A reduction in generation of each waste type is calculated and scored (1 to 4 points) then summed. The sum for the four waste types is greater than 12 points and less than 16.
- An annual increase in the types and amounts of wastes and materials recycled and/or reused onsite of offsite.


End Goal in 2000
equals
50%
0%
25%
50%
75%
100%
1 point
2 points
3 points
4 points
41.7%
50%
58.3%
75%
93
94
95
96
97
98
99


End Goal in 2000
equals
33 1/3%
0%
25%
33 1/3%
50%
66 2/3%
75%
100%
1 point
2 points
3 points
4 points
27 7/9%
33 1/3%
38 8/9%
50%
93
94
95
96
97
98
99
Year

1.2.b Pollution Prevention
The Laboratory continues to survey on-site operations for opportunities to reduce waste and pollutant releases to all media. Specific opportunities are identified and success in project implementation and achievement of the agreed-to waste or pollutant reduction project goal(s) are tracked. **(Weight = 7%)**

Assumptions:

- For FY97 the performance period is July 1, 1996 through June 30, 1997.
- Criteria for selecting opportunities include reductions in the number of discharge points, chemical substitution or process changes that reduce pollutant mass emissions or releases, process changes that result in the reuse or recycling of potential pollutants, and protecting health and safety.
- The prioritization uses a weighting factor approach that includes four criteria: quantity, cost, waste type and operational factors.
- The Laboratory has in place a program of evaluating new projects and activities for pollution prevention opportunities.

Gradient:

Meets Expectations:

- An updated and prioritized list of waste reduction and pollution prevention opportunities is provided to DOE/OAK by October 31 for potential funding in that fiscal year.
- Good progress is made on funded, site-specific milestones and on achieving the agreed to waste or pollutant reduction project goal(s).

Exceeds Expectations:

- Once the projects from the October 31 list described above in "Meets" are selected by DOE for funding, the Laboratory selects two additional projects to be funded from program or overhead budgets
- Good progress is made on the scheduled milestones for these new projects.

Far Exceeds Expectations:

- Some of the Laboratory's pollution prevention projects address the transuranic, low level and low level mixed waste streams which are costly to manage, have a high toxicity and are highly radioactive.

Appendix C: DOE's Pollution Prevention Activity Plan

Implementation of the P2 activities described below is essential to meeting goals for reducing waste generation.

C.1 Pollution Prevention Policy Direction Activities

C.1.1 Establish Goals to Minimize Waste Generation and Environmental Releases

Goal-setting is a fundamental requirement in any performance-based management system and is essential if DOE is to achieve significant reductions in waste generation and environmental releases. DOE managers can more effectively plan, organize, budget for, and execute programs to achieve actual reductions in waste generation when goals are set.

Goal-setting provides targets for reducing waste generation, standards for evaluating pollution prevention progress, and a framework for decision making. Accordingly, each DOE site will set quantitative pollution prevention goals and develop plans for achieving those goals. These goals will be compatible with the overall agency goals described in Section 3.2.2 of this plan.

C.1.2 Establish Senior Management Commitment and Follow-Through for DOE Pollution Prevention Activities

A successful DOE-wide pollution prevention program depends upon proactive leadership and hands-on management by DOE and contractor senior managers. All DOE Headquarters organizations, Operations Offices, DOE facilities, laboratories, and contractor organizations must exhibit commitment to pollution prevention. The heads of these organizations will translate the Secretarial pollution prevention policy into policies specific to their sites or programs and will be accountable for incorporating them into routine operations.

C.1.3 Distinguish Pollution Prevention Budget Allocations through Activity Data Sheets

Sufficient funding is an essential aspect of managing programs, measuring organizational commitment, and performing cost/benefit analyses. Currently, the Department is inconsistently funding is pollution prevention through overhead accounts, programmatic accounts, and special project accounts. Expenditure levels for establishing and implementing site programs often are not known.

The Department must be able to distinguish pollution prevention funding from other programs and operations. Therefore, specific budgets will be established through preparation of separate Activity Data Sheets for pollution prevention activities. These Activity Data Sheets

will be included in and tracked by the ES&H Management Plan to evaluate investment in pollution prevention across the Department.

C.1.4 Promote Regulatory Review and Provide Technical Assistance

Federal and State environmental regulations and standards provide significant benefits to the public, but can sometimes hinder pollution prevention initiatives. For example, due to the lack of a "de minimus" criterion, DOE often classifies much of its municipal waste as radioactive and much of its hazardous waste as mixed. This results in the need If for expensive treatment and disposal for wastes that could otherwise be recycled, reused, or handled by commercial treatment and disposal facilities.

Risks associated with hazardous and radioactive waste need to be evaluated considering the latest scientific evidence. The Department will seek opportunities to provide technical assistance to those formulating Federal and State environmental regulations. The Department will seek to promote cost-effective pollution prevention actions as opposed to expensive waste treatment, storage, and disposal practices.

C.1.5 Consistent DOE Policies and Procedures to Integrate Pollution Prevention

Various DOE guidance documents and directives may inadvertently create barriers to pollution prevention. Examples of these include security issues with recycling, the inability to substitute materials due to restrictive standard operating procedures, and a focus on pollution control versus pollution prevention. Applicable DOE policies and Orders must be updated to outline pollution prevention roles and responsibilities, develop consistent procedures, and create an environment to resolve internal conflicts over such matters. Therefore, DOE policies and procedures will be updated to reflect the Department's and the Administration's focus on integrating pollution prevention objectives into all activities.

C.2 Pollution Prevention Infrastructure Development

C.2.1 Establish Clear and Accountable Performance Measures

Performance measures can be established when standardized material and waste tracking systems are developed. Quantitative measurements of DOE's pollution prevention progress are difficult because of the variety of waste generating activities, such as production, laboratory experimentation, and environmental restoration. DOE currently lacks the ability to fully track across multiple sites the amounts of waste generated and pollutants released as a result of its activities. Required data often are gathered manually through time consuming and expensive "data calls" to the field. Definition and interpretation issues often restrict the value of the final roll-up information. Performance measures for pollution prevention must be developed and applied consistently throughout all DOE organizations for the data to be valid and useful for the complex. To assist in this task, the Department will develop standards and criteria to measure materials and wastes and provide performance requirements for material

and waste tracking systems. This will provide DOE managers with the information needed to establish meaningful goals for reducing waste generation and environmental releases, evaluate progress, and evaluate compliance with regulatory and Departmental drivers.

C.2.2 Analyze Pollution Prevention Costs and Benefits for Use In Decision Making

Currently, DOE does not know the full costs (direct plus hidden costs) of managing the Department's many individual waste streams and emissions, and associated loss of production efficiency due to excess energy and material usage. Material and waste management costs, including. Those paid by generators, must be estimated if DOE decision makers are to properly balance the benefits of applying pollution prevention versus the costs to continue operations without process improvements. DOE decisions on how best to manage existing and future waste streams must be made with a full understanding of future cost liability if DOE is to minimize the total cost to the taxpayers.

The Department will develop standards for estimating the costs and benefits of introducing pollution prevention into its operations. Economic analyses will provide a more thorough picture of waste generation versus costs of implementing pollution prevention for more informed Departmental decision making.

C.2.3 Facilitate Pollution Prevention Technology Transfer and Information Exchange

Effective technology transfer and information exchange provides updated information to each DOE site on pollution prevention opportunities and efficient methods for implementation. This leverages Departmental resources by providing more comprehensive knowledge of pollution prevention opportunities, reduces duplication of effort, and allows sites to benefit from lessons learned at other sites. A model site program will be developed to demonstrate outstanding environmental management performance within the Department to enhance and expedite pollution prevention technology transfer and information exchange. The Department will enhance existing systems to optimize technology transfer and information exchange within the DOE complex to provide consistent application of pollution prevention opportunities. The Department will also cooperate with other Federal, State, and local agencies, and industry to share pollution prevention technologies and information.

C.2.4 Develop a DOE Pollution Prevention Incentives Program

Incentives are necessary to stimulate and maintain interest in changing processes and activities. Providing budgetary incentives within the Department is difficult because waste management is funded by the EM organization as a service to all other waste generating organizations. Consequently, waste generators are not directly charged for waste management costs, nor do they financially benefit from reducing waste generation and environmental release rates. Without incentives, beneficial changes in generator facilities

might not be made if there are no immediate avoided costs to the generator. To help remedy that situation, the Department will acknowledge and reward reductions in waste generation and environmental releases made by the responsible line organizations

C.2.5 Develop and Conduct Pollution Prevention Employee Training and Awareness Programs

Employee pollution prevention training is integral to increasing awareness of environmental issues and the positive effects each employee can have on the environment. DOE has found it particularly difficult to reach and educate all DOE and contractor employees who generate hazardous, radioactive, mixed, and or municipal waste in their day-to-day activities. Adoption of pollution prevention practices by all management levels and the work force requires effective training programs that articulate program requirements and benefits.

The goal is to make each DOE and contractor employee aware of waste generation, its impact on the site and the environment, and ways resources may be conserved and waste generation and environmental releases reduced. The Department will operate a comprehensive pollution prevention training program that considers all applicable job-specific situations to achieve this goal.

C.2.6 Develop and Implement a Pollution Prevention Outreach and Public Involvement Program

The public understands that effective application of pollution prevention promotes health, safety, and environmental quality. Keeping stakeholders informed of DOE's progress will build public confidence and institutional credibility. The Department will involve stakeholders and local communities in pollution prevention programs and invite them to participate in emergent environmental activities and initiatives. DOE must have a visible and active program if it wishes to convince the public that it will protect future generations as it cleans up the waste of the past and responsibly manages new waste generating activities.

C.3 Pollution Prevention Program Implementation

C.3.1 Develop and Maintain Site Pollution Prevention Programs that Comply with Federal, State, and Departmental Directives

Certain site activities must be performed at all sites regardless of the pollutant or waste types generated or the number of generator organizations. Such activities include sitewide coordination, planning, reporting, training, employee awareness, assessments, and recycling and affirmative procurement programs. The Department will develop core pollution prevention activities and services at every site. **Figure C.3.1** contains the key elements of a sitewide program. These elements and sub-elements may be considered tasks and sub-tasks of a sitewide program.

Currently, DOE's sitewide pollution prevention programs are constrained due to uncertainty over which DOE line organization (EM, the landlord, waste generator) is responsible for funding and managing these activities. DOE will clarify its organizational roles and responsibilities to ensure stable funding and consistent management of site pollution prevention programs that comply with applicable Federal, State, and Departmental directives.

C.3.2 Develop and Maintain Consistent Generator-Specific Programs

Waste generator organizations must implement essential process, material, and capital equipment changes and waste avoidance techniques within operating facilities to achieve real and substantial reductions in DOE's waste generation rates. Senior management leadership is particularly needed today to accomplish this mission within the Department. Generators must perform opportunity assessments to identify pollution prevention opportunities. Generators must also plan and budget for cost-effective changes in their operations and include pollution prevention programs within their multi-year program plans.

Key elements of a generator-specific program include program management and coordination, planning and training, performance of opportunity assessments, implementation of pollution prevention techniques, goal-setting and tracking, and program progress evaluation. The Department will require waste generating organizations to include appropriate pollution prevention concepts and techniques in their program operations and other activities such as weapons disassembly, stabilization, deactivation, and environmental restoration. **Figure C.3.2** contains the key elements of a generator-specific program. These elements and sub-elements may be considered tasks and sub-tasks of a generator-specific program.

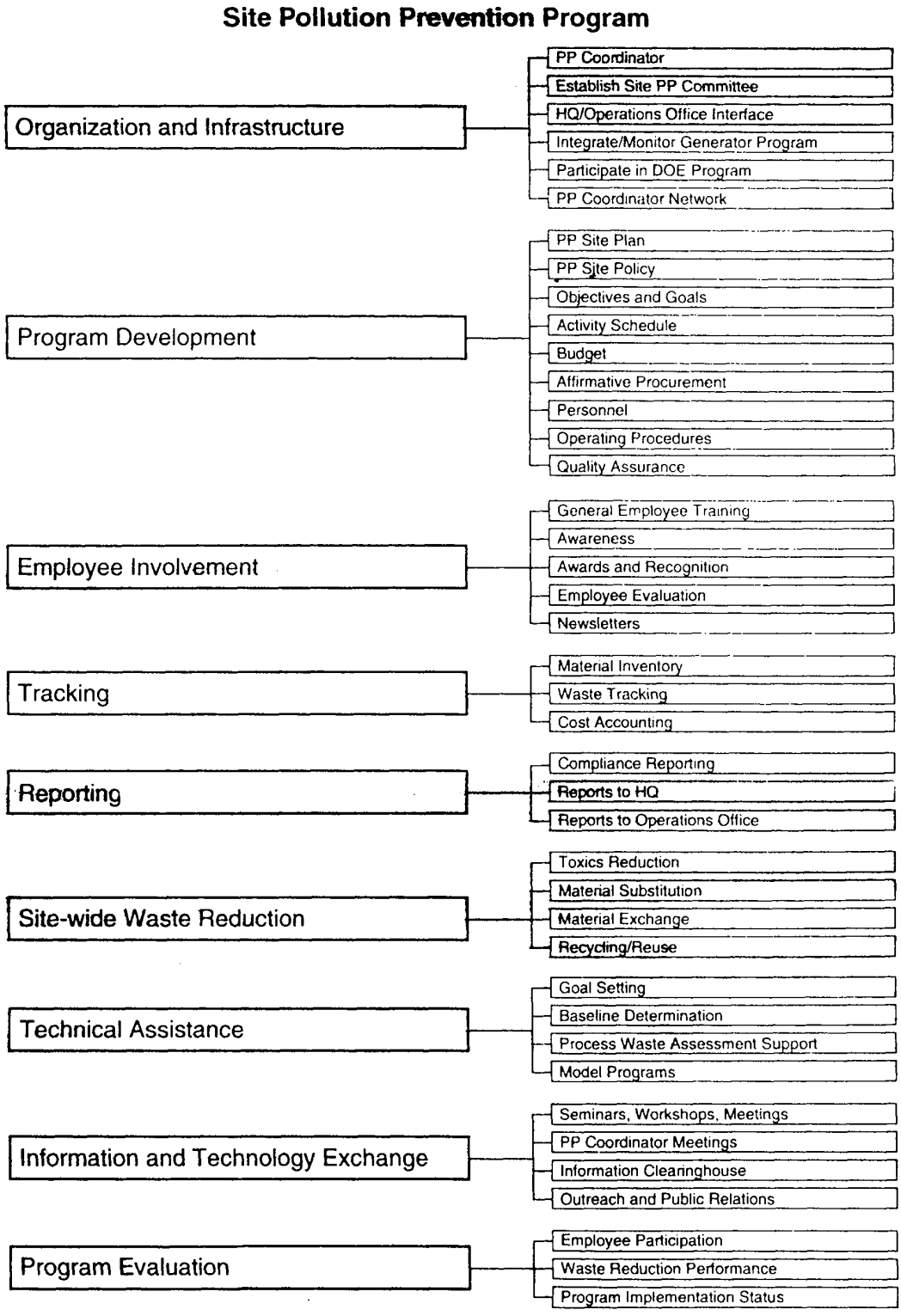


Figure C.3.1 Site Pollution Prevention Program

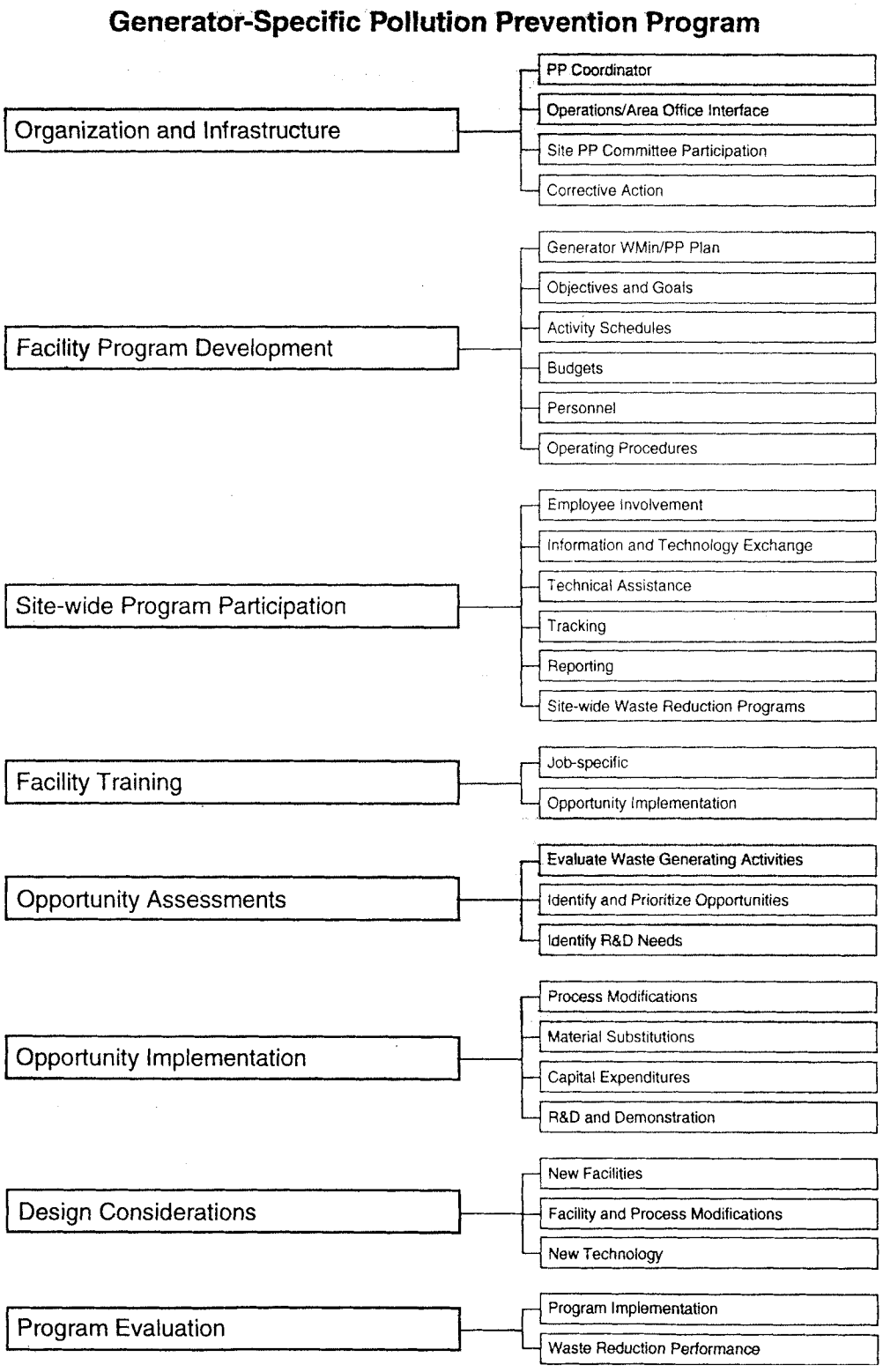


Figure C.3.2 Generator Specific Pollution Prevention Program

C.3.3 Perform Opportunity Assessments and Implement Pollution Prevention Projects

In addition to meeting its immediate environmental regulatory requirements, the Department has a responsibility to the public to reduce future pollution associated with waste generated today. Opportunity assessments provide the first-step in identifying cost-effective techniques to reduce waste generation and pollutants. An opportunity assessment involves an in-depth examination of processes, operations, and procedures and assists in identifying pollution prevention projects that will yield a quick return on investment. The Department, acting to minimize total costs, will perform opportunity assessments and identify and implement projects that show a rapid (within 36 months) return on investment.

C.3.4 Design Pollution Prevention Into New Products, Processes, and Facilities

Engineering design is a critical component of DOE's products, processes, and facilities. It is estimated that 70 percent or more of the opportunity to reduce or eliminate pollutants exists during design. Designing pollution prevention into new DOE products, processes, and facilities prevents or greatly reduces environmental releases, promotes efficient energy and materials use, and leads to lowest agency life-cycle costs. This effort is also known as "Design for the Environment."

The Department will integrate Pollution Prevention into all new design criteria. Resource efficiency will be considered a priority in all new designs or redesigns for products, processes, and facilities. Pollution prevention considerations will be included in preparation of environmental assessments and environmental impact statements under NEPA.

C.3.5 Integrate Pollution Prevention into Research, Development, Demonstration, Test, and Evaluation Projects

The Department faces significant technical hurdles, particularly for its mixed and radioactive waste streams, that will continue to impede waste management progress and increase costs until satisfactory technical solutions are developed. Applying pollution prevention research, development, demonstration, test, and evaluation (RDDT&E) solutions to critical areas of need is essential because of the size and technical challenges of the Department's waste management program. The Department will integrate waste generation and RDDT&E to ensure that pollution prevention RDDT&E projects offering the greatest technical benefit are available to generator organizations.

C.3.6 Modify Procurement Practices to Promote Pollution Prevention

As a significant purchaser of materials and equipment, the Department will promote the purchase of less toxic, more durable, more energy efficient materials, including products

composed of recovered materials, for its own operations. The Department will ensure the use of environmentally sound practices in the procurement process including updating user specifications, contracts, and policies. This will ensure that DOE and its contractors act according to existing Federal, State and local regulations, and DOE Orders and policies. Special priority within this activity will be given to meeting the requirements of Executive Order 12856, "Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements," Executive Order 12843, "Procurement Requirements and Policies for Ozone-Depleting Substances," and Executive Order 12873, "Federal Acquisition, Recycling, and Waste Prevention."

C.3.7 Reduce Releases of Toxic Chemicals

The Department will reduce the releases and offsite transfers of TRI chemicals 50 percent by December 31, 1999. All sites that meet the EPCRA toxic chemical use reporting thresholds will submit to EPA TRI Form Rs on each applicable chemical. Sites that did not submit TRI Reports in the past due to their Standard Industry Classification Code status began reporting with 1993 data. Each site will participate in reducing TRI chemical releases to ensure Departmental compliance with Executive Order 12856. The baseline year for measuring DOE-wide reductions under the Executive Order is 1993.

Appendix D: Regulatory Review and Analysis

Regulatory analysis consists of reviewing, providing comments, and tracking proposed new legislation and/or regulation. The goals of regulatory analysis are to:

- provide information to legislators and regulatory agencies to assist them in achieving the goals of the statute or regulation, while minimizing the burden on the regulated community.
- provide information to LLNL management, the University of California (UC) Regents, and the Department of Energy (DOE) of potential and upcoming requirements for budget and planning impacts.
- assist in developing compliance plans and in providing regulatory interpretation.

Regulatory analysis is often performed by ad hoc teams with members being drawn from many interested organizations including Permits and Regulatory Affairs Group (PRAG) in ORAD, affected programs, and other EPD organizations. For Federal legislation and regulations, comments are coordinated and transmitted through DOE. For state and local regulations, LLNL provides comments directly to the regulatory agency. As state employees (through UC Regents), LLNL is restricted from lobbying for or against proposed state legislation that may impact LLNL operations.

D.1 Promote Regulatory Review and Reform

The Environmental Protection Department (EPD) is responsible for providing assistance to line management to help ensure environmental compliance, conducting environmental restoration, and assisting the LLNL organizations in carrying out their tasks in an environmentally acceptable manner.

The Operations and Regulatory Affairs Division (ORAD) provides effective Laboratory-wide oversight of environmental compliance. ORAD:

- Provides day-to-day guidance on regulatory requirements for environmental concerns such as the management of hazardous or radioactive materials/waste, tanks, and air emissions;
- Advises program personnel on waste minimization and pollution abatement methods;
- Assists program management to identify and alleviate potential environmental compliance issues in early project planning stages;
- Assists programs in conducting compliance audits;
- Provides a chemical tracking capability and develops the associated reports;
- Responds during emergencies to advise on environmental cleanup standards, sampling, and possible reporting to regulatory agencies;

- Prepares risk assessments, reports, and documents, such as initial study input under the California Environmental Quality Act (CEQA) and Environmental Assessments (EAs) required under the National Environmental Policy Act (NEPA);
- Monitors existing and pending environmental legislation that may impact LLNL activities;
- Obtains permits from regulatory agencies to ensure that LLNL operations are in compliance with environmental laws and regulations;
- Evaluates the effectiveness of environmental control measures;
- Assesses compliance with applicable emission standards;
- Estimates the impact of ongoing LLNL operations on the surrounding environment;
- Prepares reports for DOE, regulatory agencies, and the public, summarizing monitoring results; and
- Prepares reports, conducts surveys, and advises LLNL on natural, biological, and cultural resources.

D.2 Active and Completed Regulatory Analysis Projects

D.2.1 RCRA Munitions Rule

EPA identified military munitions as a unique waste type that required special regulatory consideration due to dual regulation by DOD / DOE as an explosive and by EPA as a hazardous waste. The proposed EPA regulations are meant to reduce duplicative and / or contradictory regulatory requirements. LLNL submitted comments on the proposed RCRA Munitions Rule via DOE. Reviewers included Marjorie Gonzalez (D&NT), Rich Guarianti (B Div), and Keith Otsuki (PRAG). Rich led the (apparently successful) effort to assure the definition of military munitions would include DOE owned and developed munitions, as well as DOD materials.

D.2.2 RCRA Subpart CC Rule

EPA adopted 40 CFR 264 subpart CC to establish air emission standards for tanks, surface impoundments and containers used to contain hazardous waste. Karen Doiron (PRAG) and Dixie Findley (HWM) reviewed the regulatory requirements and developed a compliance plan.

D.2.3 RCRA Hazardous Waste Identification Rule (HWIR)

EPA was mandated by the Federal judicial system to provide a defensible basis for determining whether a waste is hazardous. The Hazardous Waste Identification Rule (HWIR) is EPA's attempt to use risk assessment methodolgies to establish a risk-based "floor" to hazardous waste listings and provide "Exit Levels" for RCRA hazardous wastes. David Epley (PRAG) leads the effort to review the proposed regulation and to track progress.

D.2.4 TSCA Polychlorinated Biphenyl (PCB) Regulations

EPA has published (12/94) proposed modifications to regulations for Polychlorinated Biphenyls (PCBs) under the Toxic Substances Control Act (TSCA). Ellen Eagan-McNeill (PRAG) has reviewed the proposed regulation and continues to track the regulations progress.

D.2.5 AB1540

California State Assembly Bill (AB) 1540 mandated the Department of Toxic Substances Control (DTSC) to amend existing state regulations on treatability studies to provide regulatory relief and to conform with Federal standards. While the bill was approved in 1995(?), the modified regulations have not yet been written or proposed. Ellen Eagan-McNeill (PRAG) and Stan Terusaki (PRAG) are tracking this issue.

D.2.6 SJVUAPCD Ozone Attainment Plan

The San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) adopted an Ozone Attainment Plan for compliance with the national ozone standard by 1999. Willie Montemayor (PRAG) attended the public workshops for the proposed plan and reviewed/summarized the potential impact of the plan on LLNL operations. The plan was submitted to the California Air Resources Board (CARB) for inclusion in the Sate Implementation Plan (SIP).

D.2.7 SJVUAPCD Explosives Testing Exemption (Rule 2020)

While the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) has never regulated explosives testing, their rules and regulations do not include a specific exemption for explosive testing operations. Willie Montemayor has been working with SJVUAPCD staff on developing proposed language for an explosives testing exemption to be added to SJVUAPCD Rule 2020 (exemptions).

Within LLNL's PPG, staff have made significant contributions by being on several state-wide or regional working groups and committees that directly affect the environmental regulations that govern LLNL and similar industries. The most notable include:

D.2.8 DTSC's Alternative Solvent Criteria Development

PPG is working with DTSC and stakeholders to develop criteria for a proposed alternative solvent certification program.

D.2.9 Groundwater Disinfection Rule (GWDR) Participation:

The USEPA is tasked with developing a Groundwater Disinfection Rule as part of the SDWA (Safe Drinking Water Act) by 2000. As part of the development of this rule, LLNL Pollution Prevention Group staff have actively participated in the development of the cost/benefit

analysis process through participation on a working group tasked with identifying and valuing the most significant benefits to be derived from the rule.

D.2.10 Cost/Benefit - DoD Hydrocarbon Cleanup Demo Program:

As part of an on-going LLNL / UC study on leaking underground fuel tank (LUFT) risk-based cleanup standards for contaminated DoD sites in California, PPG staff members are working to develop cost / benefit evaluations that integrate with the risk assessment methodologies developed at LLNL to present regulators with an integrated decision-making methodology for risk-based prioritization of cleanup sites.

D.2.11 Work Smart Standards—An Overview

Work Smart Standards (WSS) is part of an overall Safety Management System that will improve safety and change and improve the working relationship between the DOE and its contractors. DOE made the Safety Management System both a policy (DOE P 450.4) and an acquisition regulation (Clause 970.5204-2), and WSS is expected to become part of the next UC contract with DOE. Implementation of the Safety Management System at LLNL will take 2 years, but the WSS component will be completed in FY 1997.

WSS places responsibility for the standards used to protect the worker, the public, and the environment in the hands of the DOE field office and the contractor. The process focuses on the work being performed, and it empowers the workers and local DOE staff, through consensus, to select ES&H standards that are based on the actual work being performed, not on compliance with one-size-fits-all requirements. Approval of the set of standards occurs at the appropriate management level closest to the work. Others cannot approve the set, require concurrence, or second-guess the standards selected.

Both the DOE operations office and the Laboratory will apply the process and select the WSS to be applicable sitewide and incorporated into the LLNL UC contract. LLNL Director, C. Bruce Tarter and DOE Oakland Operations Office Manager, James M. Turner will approve the set of sitewide standards. This action will align LLNL with industry practice, establish common safety expectations for the DOE and UC, help LLNL meet DOE's commitment to the Defense Nuclear Facility Safety Board, facilitate the tailoring of requirements to streamline and increase the effectiveness of safety management at LLNL.

WSS is grounded in how LLNL has traditionally controlled hazards and protected the worker, the public, and the environment. The WSS process requires an understanding of the work, an analysis of the hazards associated with the work, and the selection of standards to control the hazards. This process differs from the past in that both DOE and LLNL staff will select the WSS together, reaching consensus on the appropriate standards. Existing ES&H methodologies and documentation will support the faithful completion of the process.

Appendix E: ES&H Roles and Responsibilities

P2 is incorporated into LLNL activities through the ES&H infrastructure. Each directorate conducts periodic self-assessment activities to ensure that effective management systems for ES&H implementation are in place, and to verify that ES&H requirements are appropriately implemented in their operations and facilities. As needed, ES&H workplace activities are modified to achieve compliance.

Independent Laboratory and external oversight organizations evaluate the Laboratory's performance in meeting ES&H objectives and satisfying requirements. Where necessary, corrective actions are implemented. The Laboratory has developed a management system to implement its ES&H Program elements, that comprises the following characteristics:

- It provides for a clear definition of roles, responsibilities and authorities for ES&H matters
- It establishes formal and ad-hoc ES&H management processes in both line organizations and ES&H support organizations and
- It documents ES&H policies, requirements and guidance, and maintains records and reports of performance and assurance
- Plant Operations provides ES&H and other technical support services to all directorates, primarily through the Hazards Control, Environmental Protection, and Health Services Departments.
- Implementation of the ES&H Program is a line management responsibility that is delegated from the director to the associate directors (ADs), and then flows through each AD's line / program / discipline management chain to each employee.
- The Deputy Director for Operations advises the director on ES&H policies and institutional issues, with input from the ES&H Working Group and other ES&H committees, and oversees the effectiveness of activities and programs to implement these policies.
- ES&H institutional planning and technical support to the directorates are provided by the Plant Operations Manager.
- Assurance of ES&H program implementation is performed at the directorate level by an assurance manager who, reporting to the AD, also provides limited independent oversight.
- Institutional independent oversight of the ES&H program implementation by the directorates is performed by the Assurance Review Office (ARO).

Appendix F: Technology Transfer and Information Exchange

In 1996, the Pollution Prevention Group (PPG) completed projects in three printed circuit board shops in San Jose, in partnership with the Santa Clara County Pollution Prevention Program. Each of the shops was assessed for Pollution Prevention (P2) opportunities, and detailed reports on the fiscal, technical, and environmental benefits of the P2 opportunities were delivered to the shops.

New state-of-the-art technology, including CO2 cleaning, currently being evaluated at LLNL for optics and electronics cleaning was also evaluated, as part of the Santa Clara project, for use in the printed circuit board industry, as a novel way to strip boards of photoresists. In addition, a P2 training course was conducted with representatives from other printed circuit board shops in California and Arizona.

In Alameda County, LLNL is partnering with the Alameda County Waste Management Source Reduction and Recycling Board to provide technical assistance and technology evaluation in their StopWa$te business outreach program.

A project was recently completed in Phoenix, Arizona, in conjunction with EPA Region 9, Arizona Department of Environmental Quality, and the City of Phoenix, to evaluate P2 opportunities in a plating and anodizing shop, and to conduct P2 training. The Laboratory's unique capabilities in technology evaluation were employed. Recommendations for engineering improvements in the shop's chrome plating, chrome anodizing, and wax stripping operations were developed.

Several international P2 efforts were also conducted by from LLNL. In partnership with US Agency for International Development, representative shops in electroplating and anodizing industries of Indonesia, Ecuador, and Egypt were analyzed and evaluated for cost-effective P2 opportunities. Textile and other industries in Ecuador and Bolivia were also examined. Information on efficient technologies currently in use in the United States, that would both reduce production costs and waste generation volumes, were presented to shop management. LLNL also helped to plan and conduct P2 training courses in these countries for industry managers and technical staff.

Currently, PPG staff gave P2 training and presentations in Sofia, Bulgaria, and evaluated that city's waste water management infrastructure, analyzing it for cost-beneficial waste minimization and pollution reduction opportunities.

An LLNL project is currently underway at the United Kingdom Atomic Weapons Establishment's Aldermaston facility, in which processes and waste management procedures will be evaluated for P2 potential, and technical information on P2 approaches currently implemented at Aldermaston will be analyzed for possible use at LLNL.